

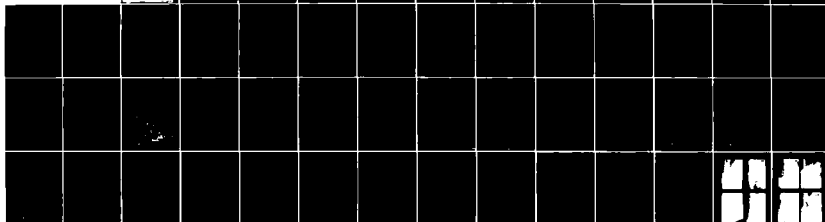
AD-A105 345

ANDERSON ENGINEERING INC SPRINGFIELD MO
NATIONAL DAM SAFETY PROGRAM. EASTLAND LAKE DAM (MO 20444), OSAG--ETC(U)
AUG 80 S L BRADY, J HEALY, & WERTEPNY
DACW43-80-C-0073

NL

UNCLASSIFIED

1 1/2
AD
A105 345



END
DATE
FILMED
11 80
DTIC

AD A105345

LEVEL

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
	AD A105345	
4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Eastland Lake Dam (MO 20444) Bates County, Missouri	5. TYPE OF REPORT & PERIOD COVERED (9) Final Report	
7. AUTHOR(s) Anderson Engineering, Inc.	6. CONTRACT OR GRANT NUMBER(s)	
	(15) DACW43-80-C-0073	
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS (11)	
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101	12. REPORT DATE August 1980	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) (6) National Dam Safety Program. Eastland Lake Dam (MO 20444), Osage-Gasconade River Basin, Bates County, Missouri. Phase I Inspection Report.	13. NUMBER OF PAGES Approximately 30	
16. DIS	15. SECURITY CLASS. (of this report) UNCLASSIFIED	
Approved for release; distribution unlimited.	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE (12) 56	
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) JAN 73		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Dam Safety, Lake, Dam Inspection, Private Dams		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.		

DD FORM 1 JAN 73 1473

EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

INSTRUCTIONS FOR PREPARATION OF REPORT DOCUMENTATION PAGE

RESPONSIBILITY. The controlling DoD office will be responsible for completion of the Report Documentation Page, DD Form 1473, in all technical reports prepared by or for DoD organizations.

CLASSIFICATION. Since this Report Documentation Page, DD Form 1473, is used in preparing announcements, bibliographies, and data banks, it should be unclassified if possible. If a classification is required, identify the classified items on the page by the appropriate symbol.

COMPLETION GUIDE

General. Make Blocks 1, 4, 5, 6, 7, 11, 13, 15, and 16 agree with the corresponding information on the report cover. Leave Blocks 2 and 3 blank.

Block 1. Report Number. Enter the unique alphanumeric report number shown on the cover.

Block 2. Government Accession No. Leave Blank. This space is for use by the Defense Documentation Center.

Block 3. Recipient's Catalog Number. Leave blank. This space is for the use of the report recipient to assist in future retrieval of the document.

Block 4. Title and Subtitle. Enter the title in all capital letters exactly as it appears on the publication. Titles should be unclassified whenever possible. Write out the English equivalent for Greek letters and mathematical symbols in the title (see "Abstracting Scientific and Technical Reports of Defense-sponsored RDT/E," AD-667 000). If the report has a subtitle, this subtitle should follow the main title, be separated by a comma or semicolon if appropriate, and be initially capitalized. If a publication has a title in a foreign language, translate the title into English and follow the English translation with the title in the original language. Make every effort to simplify the title before publication.

Block 5. Type of Report and Period Covered. Indicate here whether report is interim, final, etc., and, if applicable, inclusive dates of period covered, such as the life of a contract covered in a final contractor report.

Block 6. Performing Organization Report Number. Only numbers other than the official report number shown in Block 1, such as series numbers for in-house reports or a contractor/grantee number assigned by him, will be placed in this space. If no such numbers are used, leave this space blank.

Block 7. Author(s). Include corresponding information from the report cover. Give the name(s) of the author(s) in conventional order (for example, John R. Doe or, if author prefers, J. Robert Doe). In addition, list the affiliation of an author if it differs from that of the performing organization.

Block 8. Contract or Grant Number(s). For a contractor or grantee report, enter the complete contract or grant number(s) under which the work reported was accomplished. Leave blank in in-house reports.

Block 9. Performing Organization Name and Address. For in-house reports enter the name and address, including office symbol, of performing activity. For contractor or grantee reports enter the name and address of the contractor or grantee who prepared the report, and identify the appropriate corporate division, school, laboratory, etc., of the author. List city, state, and ZIP Code.

Block 10. Program Element, Project, Task Area, and Work Unit Numbers. Enter here the number code from the applicable Department of Defense form, such as the DD Form 1498, "Research and Technology Work Unit Summary" or the DD Form 1634, "Research and Development Planning Summary," which identifies the program element, project, task area, and work unit or equivalent under which the work was authorized.

Block 11. Controlling Office Name and Address. Enter the full, official name and address, including office symbol, of the controlling office. (Equates to funding/sponsoring agency. For definition see DoD Directive 5200.20, "Distribution Statements on Technical Documents.")

Block 12. Report Date. Enter here the day, month, and year or month and year as shown on the cover.

Block 13. Number of Pages. Enter the total number of pages.

Block 14. Monitoring Agency Name and Address (if different from Controlling Office). For use when the controlling or funding office does not directly administer a project, contract, or grant, but delegates the administrative responsibility to another organization.

Blocks 15 & 15a. Security Classification of the Report: Declassification/Downgrading Schedule of the Report. Enter in 15 the highest classification of the report. If appropriate, enter in 15a the declassification/downgrading schedule of the report, using the abbreviations for declassification/downgrading schedules listed in paragraph 4-207 of DoD 5200.1-R.

Block 16. Distribution Statement of the Report. Insert here the applicable distribution statement of the report from DoD Directive 5200.20, "Distribution Statements on Technical Documents."

Block 17. Distribution Statement (of the abstract entered in Block 20, if different from the distribution statement of the report). Insert here the applicable distribution statement of the abstract from DoD Directive 5200.20, "Distribution Statements on Technical Documents."

Block 18. Supplementary Notes. Enter information not included elsewhere but useful, such as: Prepared in cooperation with ... Translation of (or by) ... Presented at conference of ... To be published in ...

Block 19. Key Words. Select terms or short phrases that identify the principal subjects covered in the report, and are sufficiently specific and precise to be used as index entries for cataloging, conforming to standard terminology. The DoD "Thesaurus of Engineering and Scientific Terms" (TEST), AD-672 000, can be helpful.

Block 20. Abstract. The abstract should be a brief (not to exceed 200 words) factual summary of the most significant information contained in the report. If possible, the abstract of a classified report should be unclassified and the abstract to an unclassified report should consist of publicly-releasable information. If the report contains a significant bibliography or literature survey, mention it here. For information on preparing abstracts see "Abstracting Scientific and Technical Reports of Defense-Sponsored RDT&E," AD-667 000.



REPLY TO
ATTENTION OF

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

SUBJECT: Eastland Lake Dam
Bates County, Missouri
Missouri inventory No. 20444

This report presents the results of field inspection and evaluation of the Eastland Lake Dam. It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

- a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.
- b. Overtopping of the dam could result in failure of the dam.
- c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY:

SIGNED

Chief, Engineering Division

4 NOV 1980

Date

APPROVED BY:

SIGNED

Colonel, CE, District Engineer

4 NOV 1980

Date

Inspected For	
THIS DAM	<input checked="checked" type="checkbox"/>
NO. 1	<input type="checkbox"/>
NO. 2	<input type="checkbox"/>
Distribution	
Availability Codes	
Dist	Avail and/or Special
A	

OSAGE-GASCONADE RIVER BASIN

EASTLAND LAKE DAM
BATES COUNTY, MISSOURI
MISSOURI INVENTORY NO. 20444

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared By

Anderson Engineering, Inc., Springfield, Missouri
Hanson Engineers, Inc., Springfield, Illinois

Under Direction Of

St. Louis District, Corps of Engineers

For

Governor of Missouri

AUGUST, 1980

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM
SUMMARY

Name of Dam: Eastland Lake Dam
State Located: Missouri
County Located: Bates
Stream: Tributary of Muddy Creek
Date of Inspection: July 16, 1980

Eastland Lake Dam was inspected by an interdisciplinary team of engineers from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The purpose of this inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and they have been developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, the St. Louis District, Corps of Engineers has determined that this dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur if the dam fails. The estimated damage zone extends approximately two miles downstream of the dam. Located within this zone are several dwellings and buildings, a railroad fill barrier and a highway fill barrier (U. S. Highway 71).

The dam is in the small size classification, since it is less than 40 ft high, and the maximum storage capacity is greater than 50 ac-ft but less than 1,000 ac-ft.

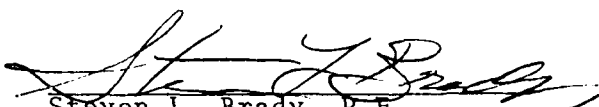
-Our inspection and evaluation indicates that the combined spillways do not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The combined spillways will pass 36 percent of the Probable Maximum Flood without overtopping. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The guidelines require that a dam of small size with a high downstream hazard potential pass 50 to 100 percent of the PMF. Considering the height of dam (16 feet), the maximum storage capacity (75 acre-feet), and the presence of the downstream railroad and highway fill barriers,

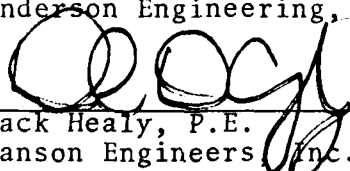
50 percent of the PMF has been determined to be the appropriate spillway design flood. The 100-year flood (1 percent probability flood) will not overtop the dam. The 1 percent probability flood is one that has a 1 percent chance of being equaled or exceeded in any given year.

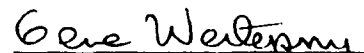
The dam appears to be in fair condition. Deficiencies visually observed by the inspection team were: (1) surface cracking on the crest of dam; (2) some sloughing of the upstream slope; (3) numerous animal burrows; (4) erosion of upstream face of dam (lack of wave protection); (5) trees and brush on slopes of embankment; (6) reported seepage along downstream toe of embankment; (7) trees and brush in west abutment spillway channel; and (8) lack of non-erodible spillway section.

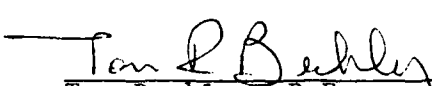
Another deficiency was the lack of seepage and stability analysis records.


It is recommended that the owners take the necessary action without undue delay to correct the deficiencies reported herein. A detailed discussion of these deficiencies is included in the following report.


Steven L. Brady, P.E.
Anderson Engineering, Inc.


For Jack Healy, P.E.
Hanson Engineers, Inc.


Gene Wertepny, P.E.
Hanson Engineers, Inc.


Tom Beckley, P.E.
Anderson Engineering, Inc.


Brad Parrish, E.I.T.
Anderson Engineering, Inc.



AERIAL VIEW OF LAKE AND DAM

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
EASTLAND LAKE DAM
MISSOURI INVENTORY NO. 20444

TABLE OF CONTENTS

<u>Paragraph No.</u>	<u>Title</u>	<u>Page No.</u>
	SECTION 1 - PROJECT INFORMATION	
1.1	General	1
1.2	Description of the Project	1
1.3	Pertinent Data	3
	SECTION 2 - ENGINEERING DATA	
2.1	Design	6
2.2	Construction	7
2.3	Operation	7
2.4	Evaluation	7
	SECTION 3 - VISUAL INSPECTION	
3.1	Findings	8
3.2	Evaluation	9
	SECTION 4 - OPERATIONAL PROCEDURES	
4.1	Procedures	10
4.2	Maintenance of Dam	10
4.3	Maintenance of Operating Facilities	10
4.4	Description of Any Warning System in Effect	10
4.5	Evaluation	10
	SECTION 5 - HYDRAULIC/HYDROLOGIC	
5.1	Evaluation of Features	11
	SECTION 6 - STRUCTURAL STABILITY	
6.1	Evaluation of Structural Stability	15
	SECTION 7 - ASSESSMENT/REMEDIAL MEASURES	
7.1	Dam Assessment	14
7.2	Remedial Measures	15

APPENDICES

	Sheet
APPENDIX A	
Location Map	1
Vicinity Map	2
Plan, Profile and Section of Dam	3
Profile and Section of Spillway	3A
Plan Sketch of Dam	4
APPENDIX B	
Geologic Regions of Missouri	1
Thickness of Loessial Deposits	2
APPENDIX C	
Overtopping Analysis - PMF	1 - 9
APPENDIX D	
Photographs Index	1
List of Photographs	2
Photographs	3 - 4

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL:

A. Authority:

The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection be made of Eastland Lake Dam in Bates County, Missouri.

B. Purpose of Inspection:

The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and a visual inspection in order to determine if the dam poses hazards to human life or property.

C. Evaluation Criteria:

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, "Recommended Guidelines for Safety Inspection of Dams, Appendix D." These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT:

A. Description of Dam and Appurtenances:

Eastland Lake Dam is an earth fill structure approximately 16 ft high and 800 ft long at the crest. The appurtenant work consists of an earth cut swale at the east abutment and an earth cut channel at the west abutment (initial spillway section).

Sheet 3 of Appendix A shows a plan, profile, and typical section of the embankments. Sheet 3A of Appendix A shows a profile and section of the spillway.

B. Location:

The dam is located in the south-central part of Bates County, Missouri on a tributary of Muddy Creek. The dam and lake are within the Rich Hill, Missouri 7.5 minute quadrangle sheet (Section 12, T38N, R31W - latitude 38°04.9'; longitude 94°21.7'). Sheet 2 of Appendix A shows the general vicinity.

C. Size Classification:

With an embankment height of 16 ft and a maximum storage capacity of approximately 75 acre-ft, the dam is in the small size category.

D. Hazard Classification:

The St. Louis District, Corps of Engineers has classified this dam as a potential high hazard dam. The estimated damage zone extends approximately two miles downstream of the dam. Located within this zone are several dwellings and buildings, all in the town of Rich Hill, a railroad fill barrier and a highway fill barrier (U.S. Highway 71). The affected downstream hazard zone was verified by the inspection team.

E. Ownership:

The dam is owned by Mr. Howard Eastland. The owner's address is Rich Hill, Missouri (telephone number 816/395-2537).

F. Purpose of Dam:

The dam was constructed primarily for providing a fishing area for the local residents.

G. Design and Construction History:

The dam was constructed in 1960 by Mr. Howard Eastland. There are no design plans for the dam. Mr. Eastland stated that a core trench approximately 10 feet wide and 8 feet deep was excavated. The trench was cut to good clay. A drawdown pipe with a valve at the downstream end was installed through the embankment. The embankment fill was obtained from the lake bed.

The site location of the dam was reported to be an abandoned strip mine pit. The size of the stripping operation was unknown.

An earth cut spillway channel was constructed at the west abutment. The flow through the channel had seriously eroded, and in 1976, the channel was blocked off. The embankment was extended through the spillway channel to the west abutment. The spillway was relocated to the east abutment. A part of the embankment was removed to form the earth cut swale for the spillway channel.

No additional modifications to the dam have been reported.

II. Normal Operating Procedures:

Flows will be passed by the uncontrolled earth cut spillway at the east abutment with excess flows passing the west abutment area through the low point of the embankment into the abandoned spillway channel. The owner stated that the dam had never been overtopped.

1.3 PERTINENT DATA:

Pertinent data about the dam, appurtenant works, and reservoir are presented in the following paragraphs. Sheet 3 of Appendix A presents a plan, profile, and typical section of the embankment. Sheet 3A of Appendix A presents a profile and section of the spillway.

A. Drainage Area:

The drainage area for this dam, as obtained from the U.S.G.S. quad sheet, is approximately 183 acres.

B. Discharge at Dam Site:

- (1) All discharge at the dam site is through uncontrolled spillways.
- (2) Estimated Total Spillway Capacity at Maximum Pool (Top of Dam - El. 802.0): 925 cfs
- (3) Estimated Capacity of Principal Spillway: 205 cfs (Elev. 802.0)
- (4) Estimated Capacity of Emergency Spillway: 720 cfs (Elev. 802.0)
- (5) Estimated Experience Maximum Flood at Dam Site: Unknown
- (6) Diversion Tunnel Low Pool Outlet at Pool Elevation: Not Applicable
- (7) Diversion Tunnel Outlet at Pool Elevation: Not Applicable
- (8) Gated Spillway Capacity at Pool Elevation: Not Applicable
- (9) Gated Spillway Capacity at Maximum Pool Elevation: Not Applicable

C. Elevations:

All elevations are consistent with an assumed mean sea level elevation of 805.5 for top of steel fence post (estimated from quadrangle map).

- (1) Top of Dam: 802.0 feet, MSL
- (2) Principal Spillway Crest: 800.0 feet, MSL
- (3) Emergency Spillway Crest: 800.6 feet, MSL
- (4) Principal Outlet Pipe Invert: Not Applicable
- (5) Streambed at Centerline of Dam: 788.5 feet, MSL
- (6) Pool on Date of Inspection: 797.6 feet, MSL
- (7) Apparent High Water Mark: Unknown
- (8) Maximum Tailwater: Not Applicable
- (9) Upstream Portal Invert Diversion Tunnel: Not Applicable
- (10) Downstream Portal Invert Diversion Tunnel: Not Applicable

D. Reservoir Lengths:

- (1) At Top of Dam: 1,400 feet
- (2) At Emergency Spillway Crest: 1,200 feet
- (3) At Principal Spillway Crest: 1,150 feet

E. Storage Capacities:

- (1) At Top of Dam: 75 acre-feet
- (2) At Emergency Spillway Crest: 57 acre-feet
- (3) At Principal Spillway Crest: 51 acre-feet

F. Reservoir Surface Areas:

- (1) At Top of Dam: 15.0 acres
- (2) At Emergency Spillway Crest: 11.2 acres
- (3) At Principal Spillway Crest: 9.5 acres

G. Dam:

- (1) Type: Rolled Earth
- (2) Length at Crest: 800 feet
- (3) Height: 16 feet
- (4) Top Width: 16 feet

- (5) Side Slopes: Upstream varies from 1V on 1.2H to 1V on 6H; Downstream 1V on 4H
- (6) Zoning: Apparently Homogeneous
- (7) Impervious Core: Clay Core 10 feet wide
- (8) Cutoff: Key Trench to Clay
- (9) Grout Curtain: none

H. Diversion and Regulating Tunnel:

- (1) Type: Not Applicable
- (2) Length: Not Applicable
- (3) Closure: Not Applicable
- (4) Access: Not Applicable
- (5) Regulating Facilities: Not Applicable

I. Spillway:

I.1 Principal Spillway:

- (1) Location: East Abutment
- (2) Type: Earth Cut Swale
- (3) Upstream Channel: Earth Cut, Grass Lined Channel
- (4) Downstream Channel: Wooded, Earth Channel with mild side slopes

I.2 Emergency Spillway:

- (1) Location: West Abutment
- (2) Type: Earth Cut Swale
- (3) Upstream Channel: Earth Cut, Grass Lined Channel
- (4) Downstream Channel: Wooded, Earth Channel with mild side slopes

J. Regulating Outlets:

The only reported regulating outlet is the 4 inch pipe, with valve, through the embankment.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN:

No design computations or reports for this dam are available. No documentation of construction inspection records are known to exist. To our knowledge there are no documented maintenance data.

A. Surveys:

No information regarding pre-construction surveys was able to be obtained. The top of a steel post was used as the reference datum for all elevations obtained by the inspection team. From U.S.G.S. quad sheets, a mean sea level elevation was estimated (see sheet 3 of Appendix A).

B. Geology and Subsurface Materials:

The site is located in the Western Plains geologic region of Missouri. The Western Plains region is characterized topographically by being level to gently undulating with wide imperceptibly rising floodplains. The sedimentary rock layers exposed in the Ozarks region dip downward away from the Ozarks region and the higher and younger sedimentary deposits become the surface ledges in southwest Missouri. Generally, the soils in the Western Plains region are residual from limestone, shale, and sandstone with some loess cover in some areas. Pennsylvania sandstone and shale above the Mississippian formations formed the parent material for the soils found in the area of the dam.

Soils in the area of the dam appear to be primarily fine, sandy, silty clays with some sandstone fragments. The soils are of the Parsons - Dennis - Bates soil association. The loessial thickness map (Sheet 2 of Appendix B) indicates that some areas of this region may have between 2.5 and 5.0 feet of loess cover.

The "Geologic Map of Missouri" indicates that the nearest known fault runs in a northwest-southeasterly direction approximately 1 mile southwest of the dam site. The Missouri Geological Survey has indicated that the faults in this area are generally considered to be inactive and have been for several hundred million years. The publication "Caves of Missouri" indicates there are no known caves in Bates County.

C. Foundation and Embankment Design:

No design computations are available. Seepage and stability analyses apparently were not performed as required in the guidelines. There is apparently no particular zoning of the embankment, and no internal drainage features are known to exist.

D. Hydrology and Hydraulics:

No hydrologic and hydraulic design computations for this dam were available. Based on a field measurement of spillway dimensions, embankment elevations, and a check of the drainage area on U.S.G.S. quad sheets, hydrologic analyses using U. S. Army Corps of Engineers guidelines were performed and appear in Appendix C, Sheets 1 through 9.

E. Structure:

There are no structures associated with this dam.

2.2 CONSTRUCTION:

No construction inspection data have been obtained.

2.3 OPERATION:

Normal flows are passed by the spillway channels located at the east and west abutments.

2.4 EVALUATION:

A. Availability:

No engineering data, seepage or stability analyses, or construction test data were available.

B. Adequacy:

The engineering data available were inadequate to make a detailed assessment of the design, construction, and operation of this structure. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

C. Validity:

To our knowledge, no valid engineering data on the design or construction of the embankment are available.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS:

A. General:

The field inspection was made on July 16, 1980. The inspection team consisted of personnel from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The team members were:

Steven L. Brady, P.E. - Anderson Engineering, Inc. (Civil Engineer)
Tom Beckley, P.E. - Anderson Engineering, Inc. (Civil Engineer)
Brad Parrish, E.I.T. - Anderson Engineering, Inc. (Geotechnical Engr.)
Jack Healy, P.E. - Hanson Engineers, Inc. (Geotechnical Engineer)
Gene Wertepny, P.E. - Hanson Engineers, Inc. (Hydraulic Engineer)

Photographs of the dam, appurtenant structures, reservoir, and downstream features are presented in Appendix D.

B. Dam:

The dam appears to be in fair condition. The horizontal and vertical alignments of the dam appear to be good. The horizontal alignment is a gentle, sweeping curve concave to downstream. The vertical alignment was generally level with the embankment lowering at the west abutment in the area of the previous constructed spillway. A few small trees were noted on the upstream and downstream slopes.

Sloughing of the upstream face was noted in several areas. Erosion of the slope was prevalent along the entire length of embankment due to wave action. Surface cracking was observed in numerous areas. No additional unusual movements of the embankment were noted.

The reported 4 inch pipe and its associated valve was not located. A nearby resident stated that the pipe had not been used in a number of years. He stated that the last time he recalls it being used, the owner had to excavate a small area surrounding the valve.

No evidence of seepage was observed. The owner stated that a wet area existed at the embankment toe when the lake was at normal pool level.

Numerous animal burrows were observed on the upstream face of the embankment. The grass cover on the crest of the embankment was good. The junction of the embankment abutments appeared to be in good condition with no noticeable erosion.

Shallow auger probes into the embankment indicated that the dam consists of a light brown, sandy, silty clay (CL).

No instrumentation (monuments, piezometers, etc.) was observed.

C. Appurtenant Structures:

C.1 Principal Spillway:

The approach to the spillway channel at the east abutment is clear. No significant erosion was noted in the channel. A non-erodible spillway section was not provided. The channel is diverted well away from the embankment. The principal spillway channel was constructed 4 years ago.

C.2 Emergency Spillway:

The emergency spillway, located at the west abutment, was the principal spillway when the dam was constructed. Due to the continued usage and no non-erodible section, serious erosion had formed. The owner extended the embankment through the spillway section and repaired the eroded areas of the spillway. This area will function as the emergency spillway due to the apparent settlement of the embankment through what was the previous spillway channel. The approach to the channel was clear.

D. Reservoir:

The watershed is pastureland and cropland with mild slopes. Considerable sediment was noted in the reservoir. No sloughing or erosion of the reservoir was observed.

E. Downstream Channel:

The downstream channel is relatively well defined with mild side slopes. The channel is generally wooded and passes under a county road about 300 feet downstream of the dam.

3.2 EVALUATION:

The trees and brush on the dam can provide shelter for small animals and encourage burrowing. The surface cracking, erosion, and sloughing could worsen and adversely affect the stability of the dam. The reported seepage area could also affect the stability of the dam. The surface cracking, erosion, sloughing, and seepage should be investigated by an engineer experienced in the design and construction of dams.

Photographs of the dam, appurtenant structures, and the reservoir are presented in Appendix D.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES:

There are no operating facilities, other than the reported drawdown valve, associated with this dam. The pool is normally controlled by rainfall, runoff, evaporation, the capacity of the uncontrolled spillways, and reported seepage from the reservoir.

4.2 MAINTENANCE OF DAM:

Maintenance of the dam is accomplished on an as needed basis and is not scheduled.

4.3 MAINTENANCE OF OPERATING FACILITIES:

The apparently buried gate valve is not maintained and the inspection team is unaware of its condition.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT:

The inspection team is unaware of any existing warning system for this dam.

4.5 EVALUATION:

The reported seepage along the downstream toe, the surface cracking of the crest, the erosion of the upstream slope, the sloughing of the upstream slope, the animal burrows, the trees and brush on the embankment and spillway channel, and the lack of a non-erodible spillway section are deficiencies which should be corrected. Remedial measures should be investigated by an engineer experienced in the design and construction of dams. Subsequently, these areas should be inspected periodically to detect any further erosion or seepage.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES:

A. Design Data:

No hydrologic or hydraulic design computations for this dam were available.

B. Experience Data:

No recorded rainfall, runoff, discharge, or reservoir stage data were available for this lake and watershed. The owner reported that the dam has not been overtopped. He further stated that the spillway functions several times each year. The reported high water behind the dam was about one foot below the embankment crest.

C. Visual Observations:

The approach area to the spillway channels is clear. The channels are well separated from the embankment and spillway releases would not be expected to endanger the dam. Non-erodible sections are not provided for the spillway.

D. Overtopping Potential:

The hydraulic and hydrologic analyses (using the U. S. Army Corps of Engineers guidelines and the HEC-1 computer program) were based on: (1) a field survey of spillway dimensions and embankment elevations; and (2) an estimate of the reservoir storage and the pool and drainage areas from the Rich Hill and Sprague, Missouri 7.5 minute U.S.G.S. quad sheet.

Based on the hydrologic and hydraulic analyses presented in Appendix C, the combined spillways will pass 36 percent of the Probable Maximum Flood. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief of Engineers, require that this structure (small size with high downstream hazard potential) pass 50 percent to 100 percent of the PMF, without overtopping. Considering the height of dam (16 feet), the maximum storage capacity (75 acre-feet), and the downstream railroad and highway fill barriers, 50 percent of the PMF has been determined to be the appropriate spillway design flood. The spillways will pass a 1 percent probability flood without overtopping the dam.

Application of the probable maximum precipitation (PMP), minus losses, resulted in a flood hydrograph peak inflow of 3,204 cfs. For 50 percent of the PMF, the peak inflow was 1,602 cfs.

The routing of the PMF through the spillways and dam indicates that the dam will be overtopped by 1.0 ft at elevation 803.0. The duration of the overtopping will be 1.0 hours, and the maximum outflow will be 2,886 cfs. The maximum discharge capacity of the spillways, at elevation 802.0, is 925 cfs. The routing of 50 percent of the PMF indicates that the dam will be overtopped by 0.3 ft at elevation 802.3. The maximum outflow will be 1,339 cfs, and the duration of overtopping will be 0.4 hours. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY:

A. Visual Observations:

Observed features which could adversely affect the structural stability of this dam are discussed in Sections 3.1B and 3.2.

B. Design and Construction Data:

Seepage and stability analyses comparable to the requirements of the guidelines were not available, which constitutes a deficiency which should be rectified.

C. Operating Records:

No operating records have been obtained.

D. Post-Construction Changes:

The reported post-construction change is the construction of the spillway at the east abutment and the closing off of the spillway at the west abutment.

E. Seismic Stability:

The structure is located in seismic zone 1. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT:

This Phase I inspection and evaluation should not be considered as being comprehensive since the scope of work contracted for is far less detailed than would be required for an in-depth evaluation of dams. Latent deficiencies, which might be detected by a totally comprehensive investigation, could exist.

A. Safety:

The embankment is in fair condition. Several items were noted during the visual inspection which should be investigated further, corrected or controlled. These items are: (1) surface cracking on the crest of the dam; (2) sloughing of the upstream slope; (3) numerous animal burrows; (4) erosion of upstream slope; (5) trees and brush on the embankment; (6) reported seepage along the embankment toe; (7) trees and brush in west abutment channel; and (8) lack of non-erodible spillway section.

Another deficiency was the lack of seepage and stability analyses records.

The dam will be overtopped by flows in excess of 36 percent of the Probable Maximum Flood. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

B. Adequacy of Information:

The conclusions in this report were based on the performance history as related by others, and visual observation of external conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

C. Urgency:

The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. If the deficiencies listed in paragraph A are not corrected, and if good maintenance is not provided, the embankment condition will continue to deteriorate and possibly could become serious in the future. The items recommended in paragraph 7.2A should be pursued without undue delay.

D. Necessity for Additional Inspection:

Based on the result of the Phase I inspection, no additional inspection is recommended.

E. Seismic Stability:

The structure is located in seismic zone 1. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size.

7.2 REMEDIAL MEASURES:

The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams.

A. Alternatives:

- (1) Spillway size and/or height of dam should be increased to pass 50 percent of the PMF. In either case, the spillway should be protected to prevent erosion.

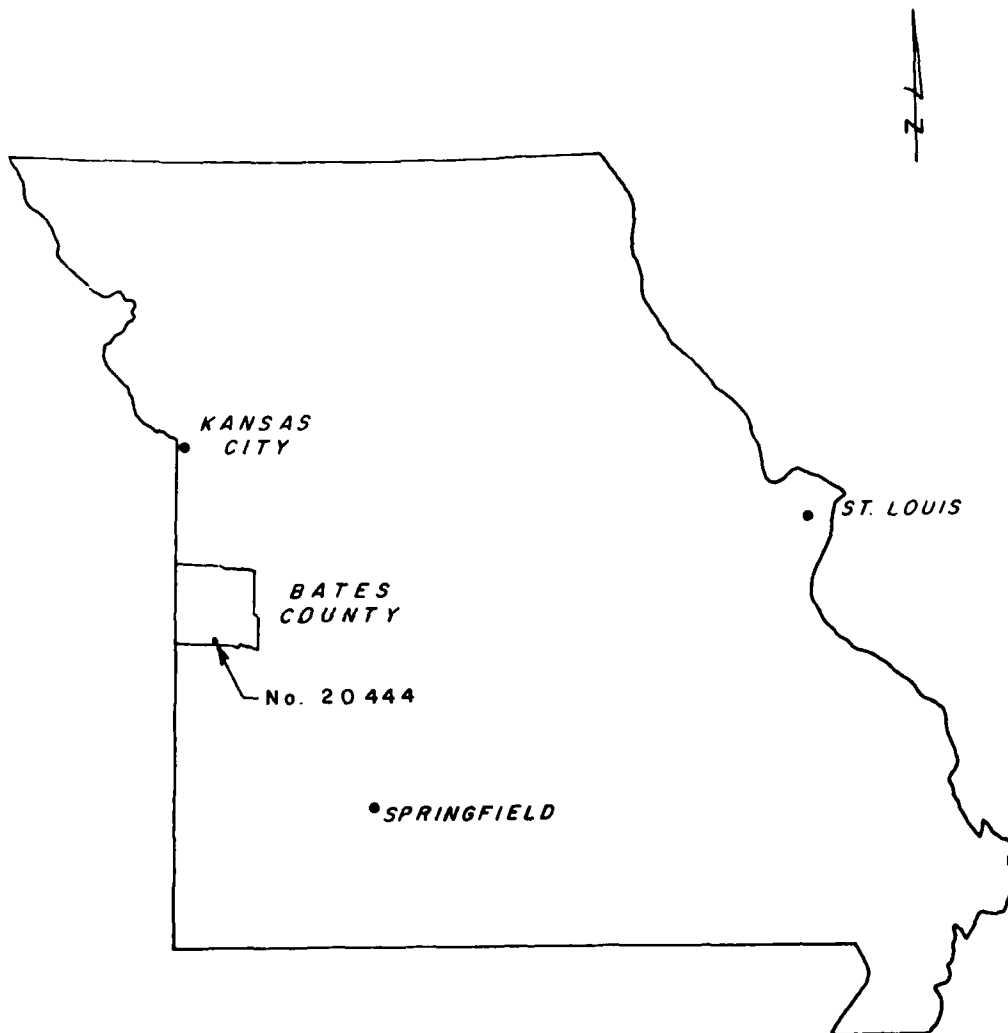
B. O & M Procedures:

- (1) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by an engineer experienced in the design and construction of dams.
- (2) The surface cracking should be investigated and repaired under the guidance of an engineer experienced in the design and construction of dams.
- (3) The sloughing and erosion of the upstream slope should be repaired and maintained. This should be repaired under the direction of an engineer experienced in the design and construction of dams.
- (4) The reported seepage area along the toe of the embankment should be investigated by an engineer experienced in the design and construction of dams. Remedial measures may be required. As a minimum, the wet areas should be drained and monitored to determine if there is any increase in quantities and whether soil particles are being carried with the water.

- (5) Wave protection should be provided for the upstream face of the embankment.
- (6) The animal burrows should be repaired and prevented.
- (7) A non-erodible spillway control section should be provided for the spillway channels.
- (8) The trees and brush on the embankment and spillway channel should be removed. The initial clearing should be done under the guidance of a professional engineer experienced in the design and construction of dams. Indiscriminate clearing methods could jeopardize the safety of the dam.
- (9) A detailed inspection of the dam should be made periodically by an engineer experienced in the design and construction of dams.

APPENDIX A

Dam Location and Plans



LOCATION MAP



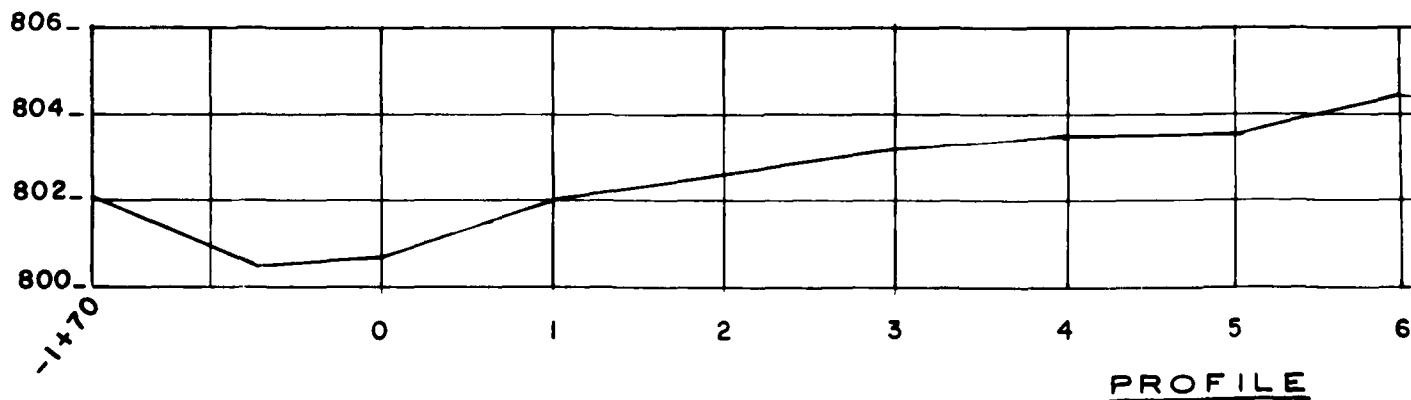
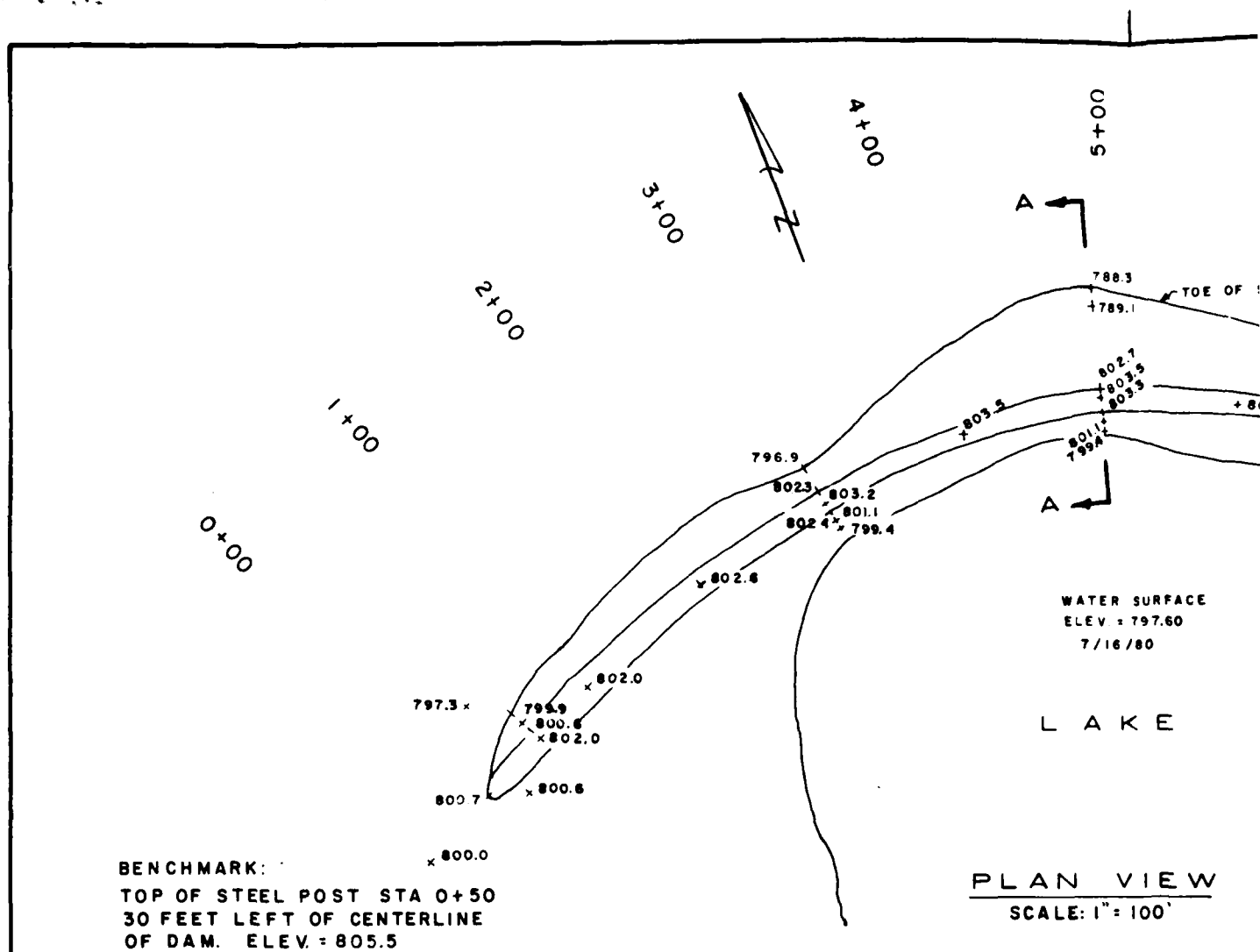
VICINITY MAP

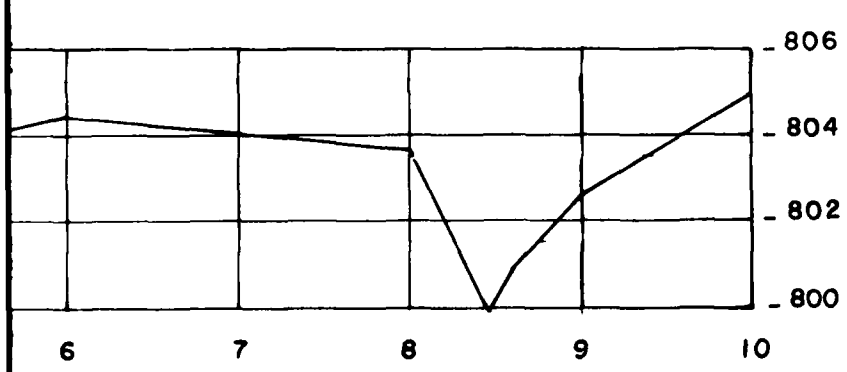
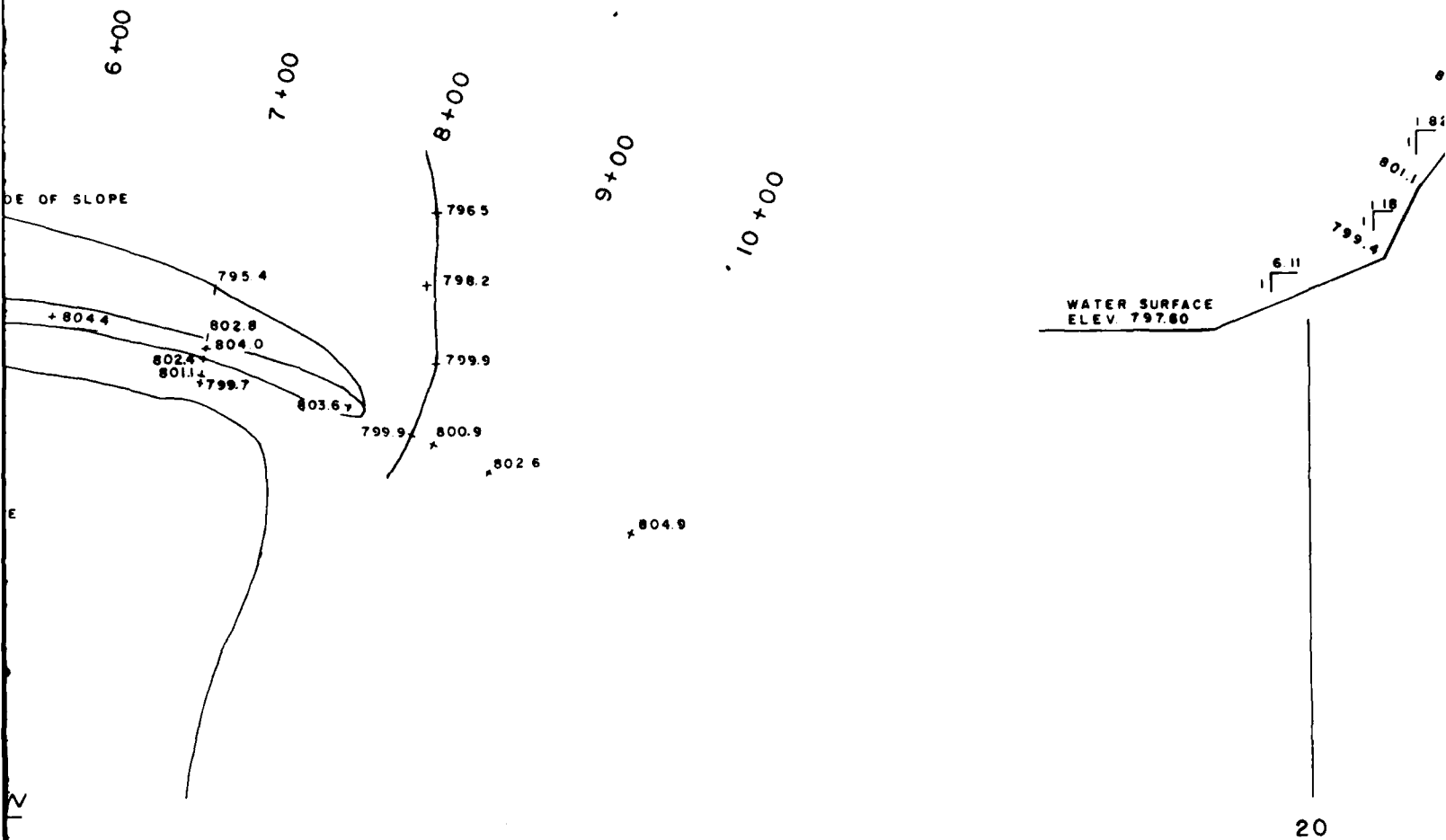


SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

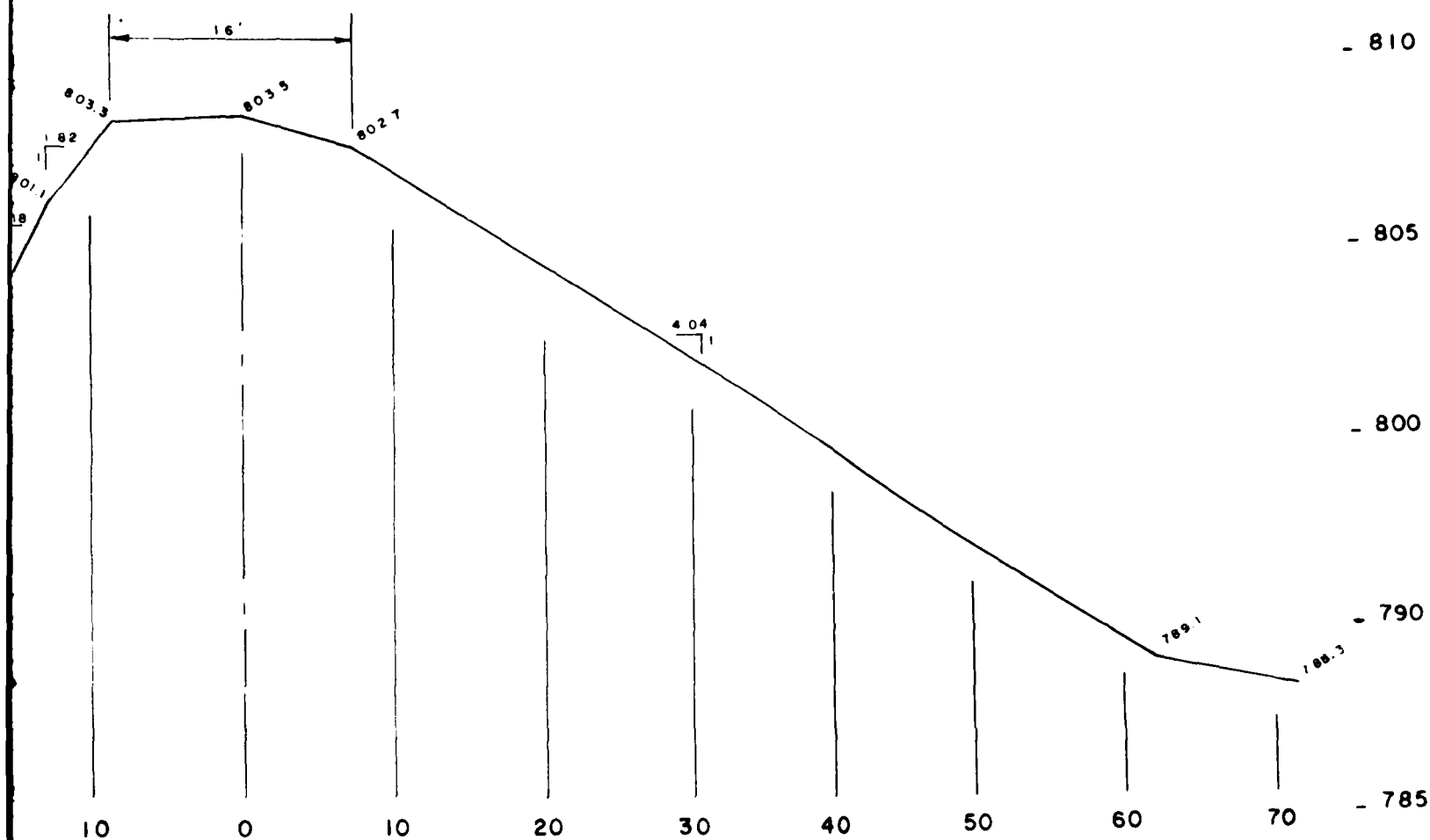
Eastman Lake Dam
Bates County, Missouri
Mo. I.D. No. 20444

Sheet 2, Appendix A





2



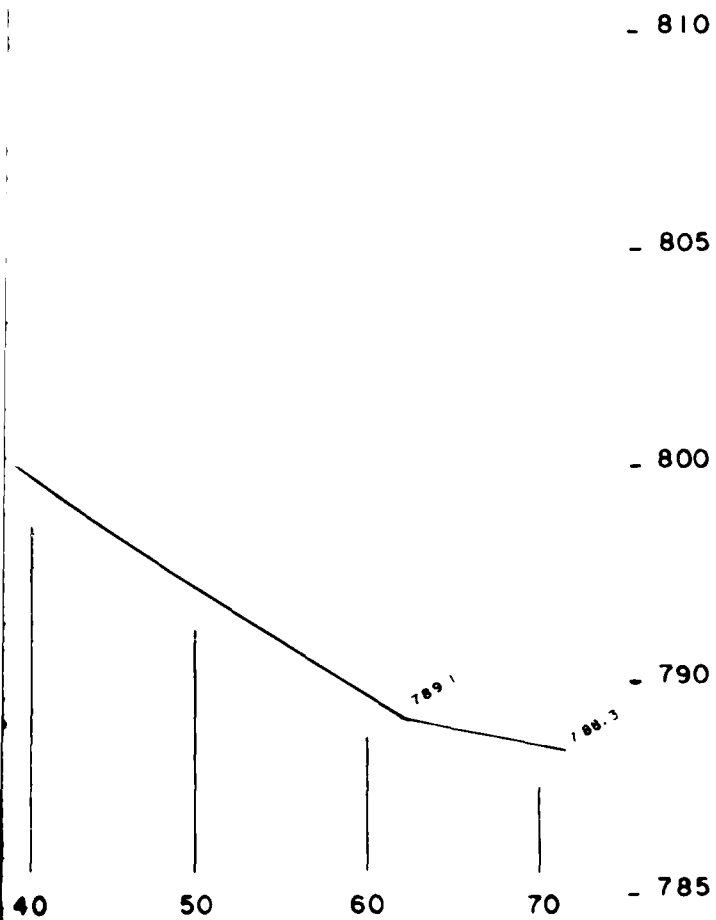
SECTION A-A STA 5+00

SHEET

ANDERS
730 NO
SPRING

EAS

3



SHEET 3 APPENDIX A

ANDERSON ENGINEERING, INC.
730 NORTH BENTON AVENUE
SPRINGFIELD, MISSOURI 65802

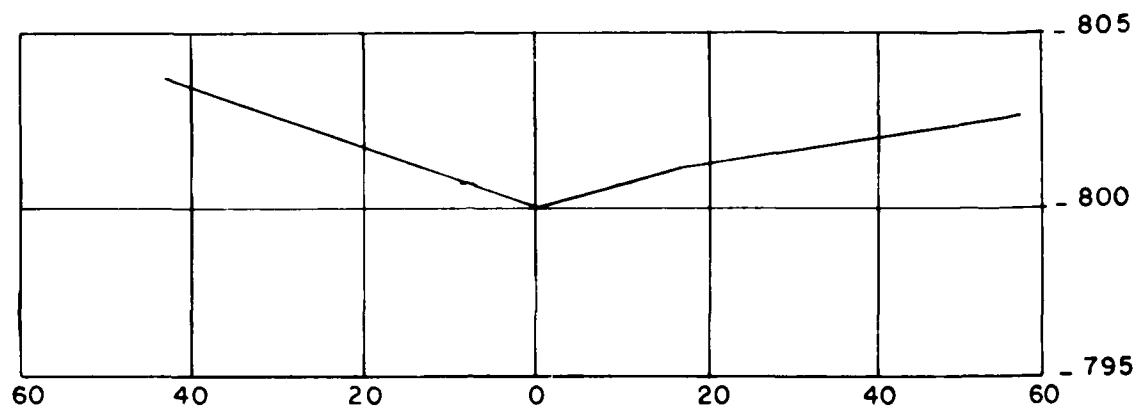
EASTLAND LAKE DAM

MO. No. 20444

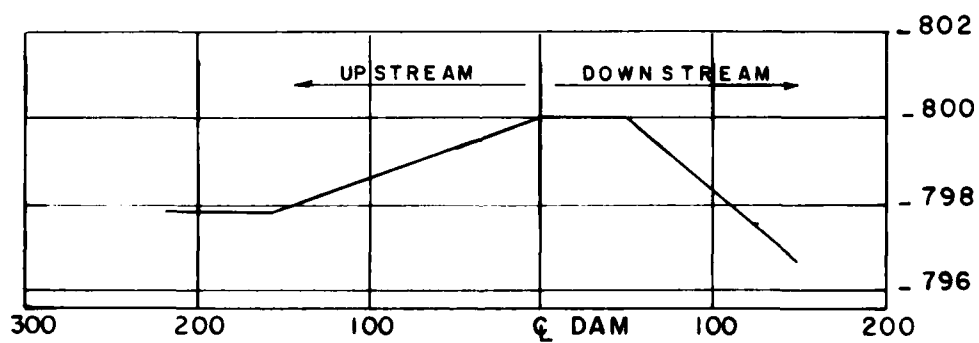
PLAN & PROFILE

BATES COUNTY, MO.

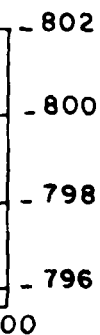
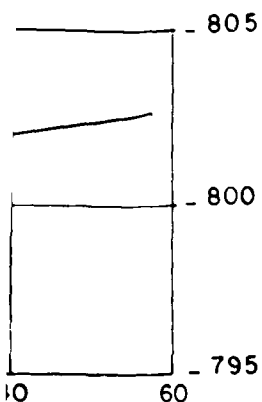
4



SPILLWAY SECTION Q DAM



SPILLWAY PROFILE



SHEET 3A APPENDIX A

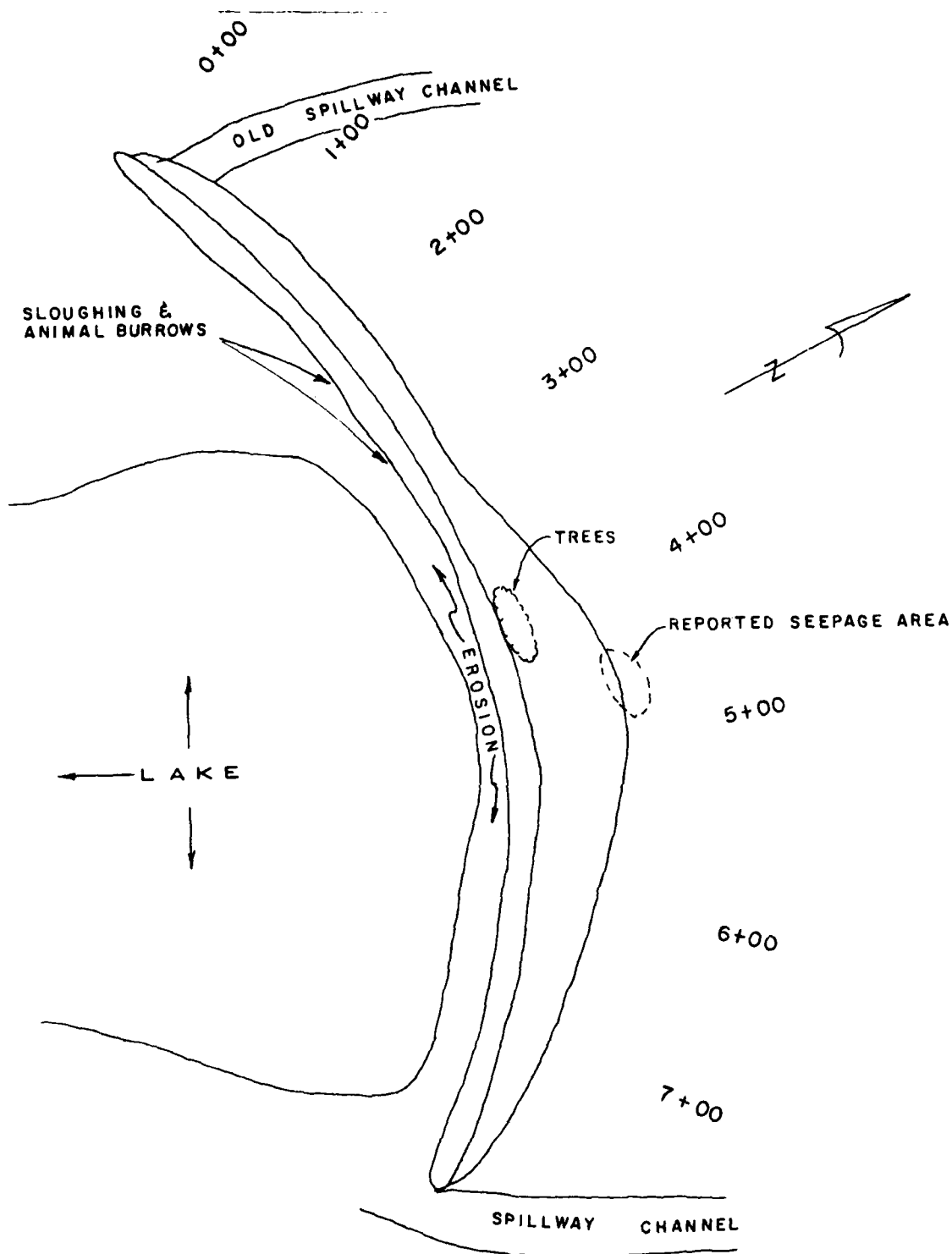
ANDERSON ENGINEERING, INC.
730 NORTH BENTON AVENUE
SPRINGFIELD, MISSOURI 65802

EASTLAND LAKE DAM

MO. No. 20444

SPILLWAY
SECTION & PROFILE
BATES COUNTY, MO.

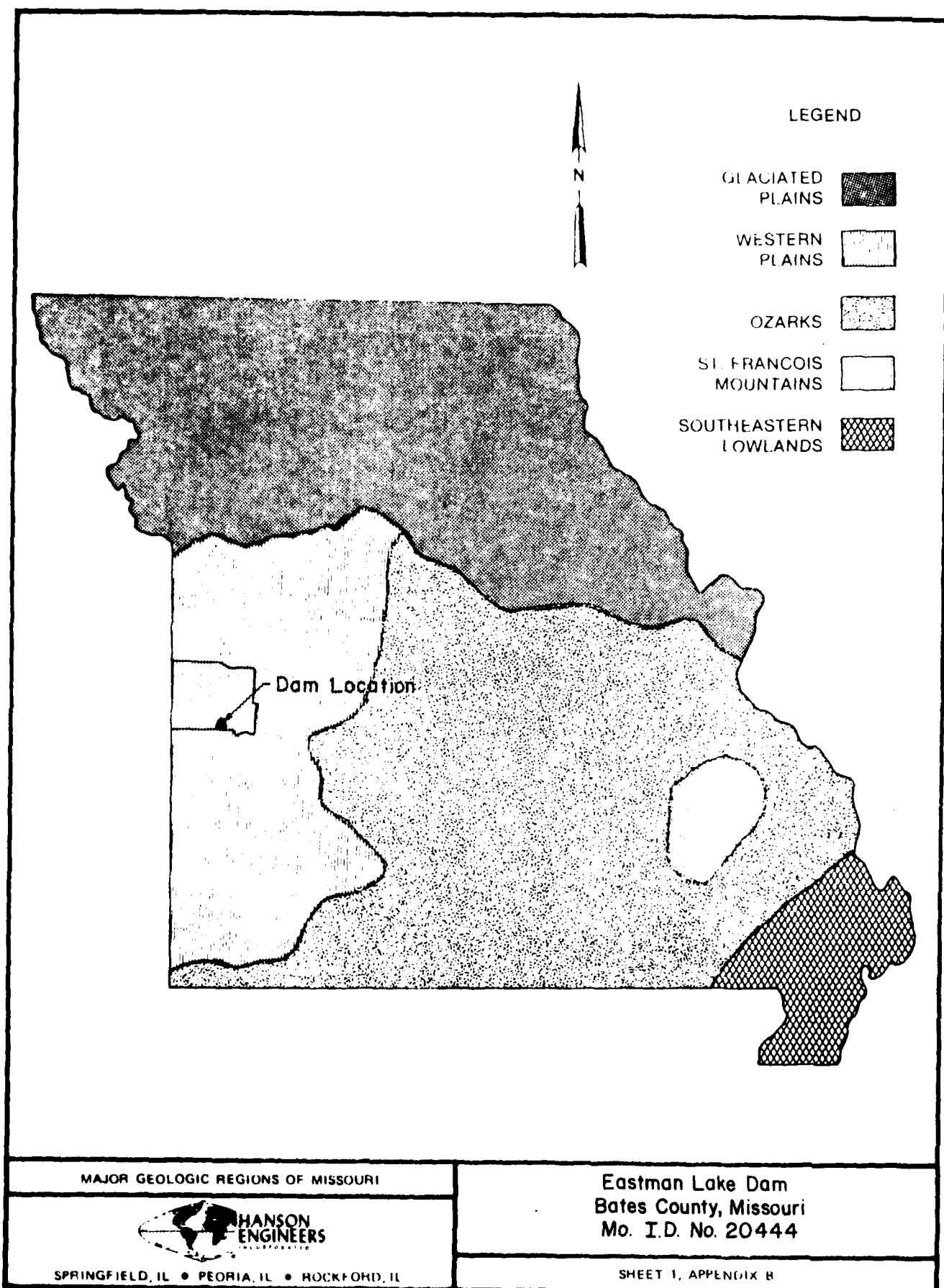
2



PLAN SKETCH OF DAM
EASTLAND LAKE DAM
MO. No. 20444

APPENDIX B

Geology and Soils



LEGEND

GLACIATED PLAINS

WESTERN PLAINS

OZARKS

ST. FRANCOIS MOUNTAINS

SOUTHEASTERN LOWLANDS

Dam Location

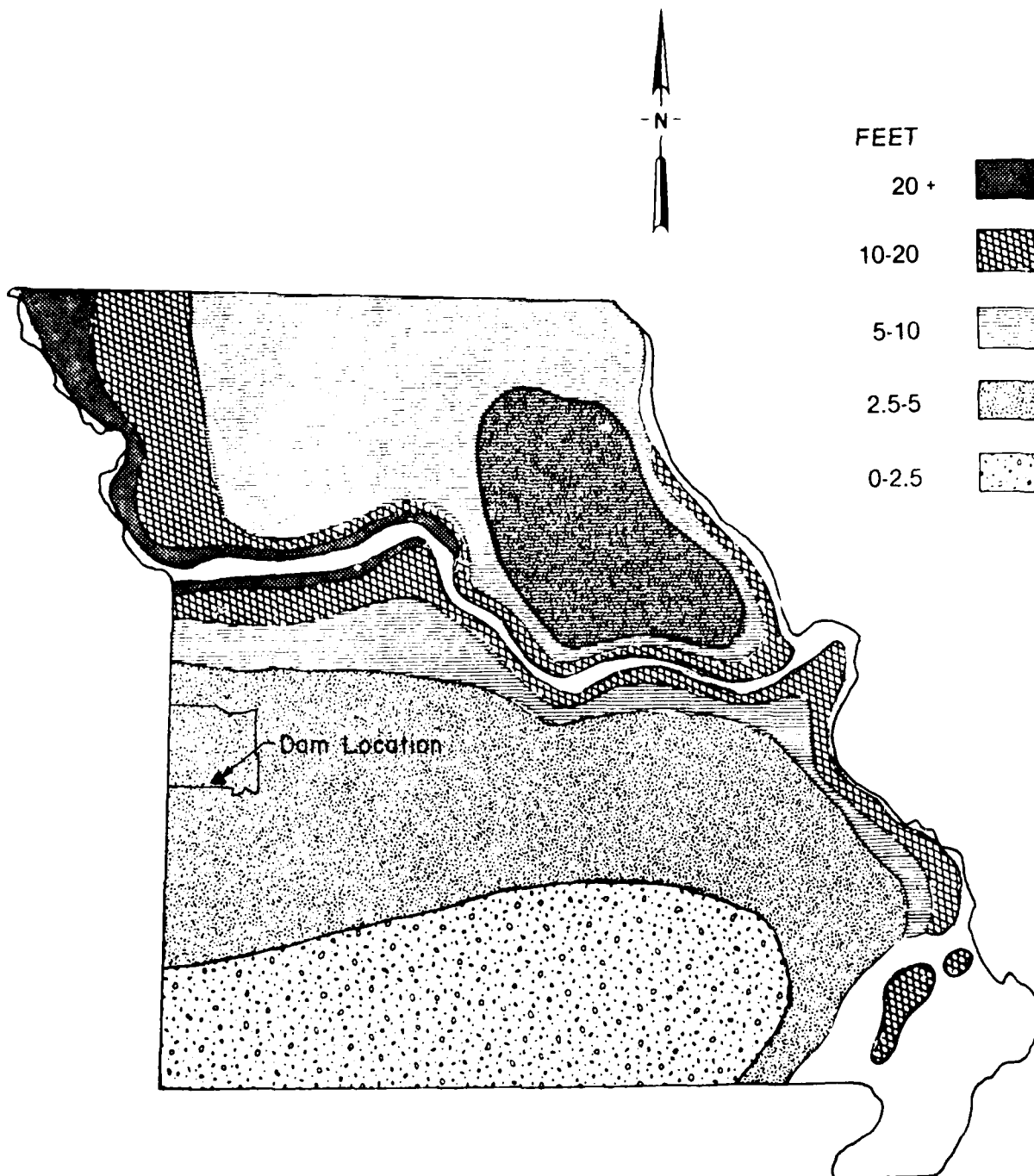
MAJOR GEOLOGIC REGIONS OF MISSOURI



SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Eastman Lake Dam
Bates County, Missouri
Mo. I.D. No. 20444

SHEET 1, APPENDIX B



THICKNESS OF LOESSIAL DEPOSITS



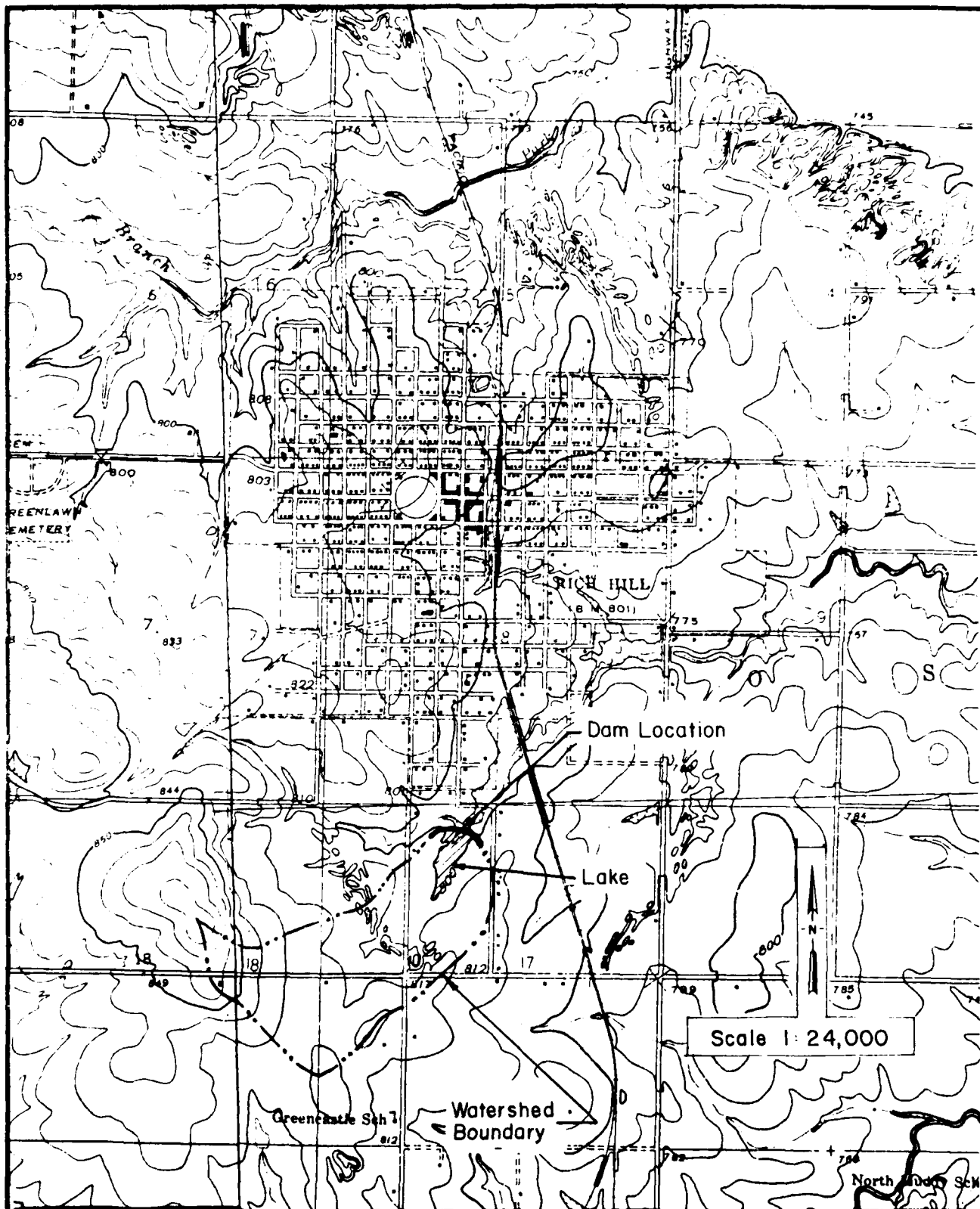
SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Eastman Lake Dam
Bates County, Missouri
Mo. I.D. No. 20444

SHEET 2, APPENDIX B

APPENDIX C

Overtopping Analysis



LAKE AND WATERSHED MAP



**HANSON
ENGINEERS**
INCORPORATED

SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Eastman Lake Dam
Bates County, Missouri
Mo. I.D. No. 20444

Sheet I , Appendix C

APPENDIX C

HYDROLOGIC AND HYDRAULIC ANALYSIS

To determine the overtopping potential, flood routings were performed by applying the Probable Maximum Precipitation (PMF) to a synthetic unit hydrograph to develop the inflow hydrograph. The inflow hydrograph was then routed through the reservoir and spillway. The overtopping analysis was accomplished using the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California.

The PMF was determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33." Reduction factors were not applied. The rainfall distribution for the 24-hour PMF storm duration was assumed according to the procedures outlined in EM 1110-2-1411 (SPD Determination). Also, the 1 percent chance probability flood was routed through the reservoir and spillway. Springfield rainfall distribution (5 min. interval - 24 hours duration), as provided by the St. Louis District, Corps of Engineers, was used in this case.

The synthetic unit hydrograph for the watershed was developed by the computer program using the SCS method. The parameters for the unit hydrograph are shown in Table 1 (Sheet 3, Appendix C).

The SCS curve number (CN) method was used in computing the infiltration losses for rainfall-runoff relationship. The CN values used, and the result from the computer output, are shown in Table 2 (Sheet 4, Appendix C).

The reservoir routing was accomplished by using the Modified Puls Method. The hydraulic capacity of the spillway was used as an outlet control in the routing. The hydraulic capacity of the spillway and the storage capacity of the reservoir were defined by the elevation-surface area-storage-discharge relationships shown in Table 3 (Sheet 4, Appendix C.)

The rating curve for the spillway (see Table 4, Sheet 5, Appendix C) was determined assuming critical flow condition at the control section for the principal spillway, and flow at critical depth in a trapezoidal channel for the emergency spillway.

The flow over the crest of the dam during overtopping was determined using the non-level dam option (\$L and \$V cards) of the HEC-1 program. The program assumes critical flow over a broad-crested weir.

A summary of the routing analysis for different ratios of the PMF is shown in Table 5 (Sheet 6, Appendix C).

The computer input data, a summary of the output data, and a plot of the inflow-outflow hydrograph for the PMF are presented on Sheets 7, 8, and 9 of Appendix C.

TABLE 1
SYNTHETIC UNIT HYDROGRAPH

Parameters:

Drainage Area (A)	0.29	sq miles
Length of Watercourse (L)	0.82	miles
Difference in elevation (H)	85	ft
Time of concentration (Tc)	0.37	hrs
Lag Time (Lg)	0.22	hrs
Time to peak (Tp)	0.26	hrs
Peak Discharge (Qp)	540	cfs
Duration (D)	5	min.

<u>Time (Min.)(*)</u>	<u>Discharge (cfs)(*)</u>
0	0
5	114
10	386
15	534
20	471
25	306
30	174
35	106
40	63
45	37
50	22
55	13
60	8
65	5
70	3
75	1

(*) From the computer output

FORMULA USED:

$$T_c = \left(\frac{11.9 L^3}{H} \right)^{0.385} \quad \text{From California Culverts Practice, California Highways and Public Works, September, 1942.}$$

$$L_g = 0.6 T_c$$

$$T_p = \frac{D}{2} + L_g$$

$$Q_p = \frac{484 A \cdot Q}{T_p} \quad Q = \text{Excess Runoff} = 1 \text{ inch}$$

TABLE 2
RAINFALL-RUNOFF VALUES

Selected Storm Event	Storm Duration (Hours)	Rainfall (Inches)	Runoff (Inches)	Loss (Inches)
PMP	24	33.54	32.35	1.19
1% Prob. Flood	24	8.00	5.60	2.40

Additional Data:

- 1) Soil Conservation Service Soil Group C
- 2) Soil Conservation Service Runoff Curve CN = 90 (AMC III) for the PMF
- 3) Soil Conservation Service Runoff Curve CN = 78 (AMC II) for the
1 percent chance flood
- 4) Percentage of Drainage Basin Impervious 8 percent

TABLE 3
ELEVATION, SURFACE AREA, STORAGE AND DISCHARGE RELATIONSHIPS

Elevation (feet-MSL)	Lake Surface Area (acres)	Lake Storage (acre-ft)	Spillway Discharge (cfs)
788.5	0	0	-
790.0	0.5	0.5	-
*800.0	9.5	51.0	0
**800.6	11.2	57.0	15
***802.0	15.0	75.0	925
805.0	23.0	132.0	-
810.0	41.0	-	-

*Principal spillway crest elevation

**Emergency spillway crest elevation

***Top of dam elevation

The above relationships were developed using data from the USGS Rich Hill, MO and Sprague, MO 7.5 minute quadrangle maps, and the field measurements.

TABLE 4
SPILLWAYS RATING CURVE

<u>Reservoir Elevation</u> (MSL)	<u>Principal Spillway</u> (cfs)	<u>Emergency Spillway</u> (cfs)	<u>Total Discharge</u> (cfs)
800.0	0	-	0
800.6	15	0	15
801.0	40	70	110
801.5	100	302	402
*802.0	205	720	925
802.5	360	1,350	1,710
803.0	600	2,210	2,810
803.3	750	2,860	3,610
804.4	1,630	4,750	6,380

*Top of dam elevation

METHOD USED:

- 1) Principal Spillway: Assuming critical flow condition at the control section

FORMULA: $\frac{Q^2}{g} = \frac{A^3}{T}$ Design of Small Dams, U.S. Bureau of Reclamation

Q = Discharge in cubic feet per second
A = Cross sectional area in square feet
T = Water surface width in feet
g = Acceleration of gravity in ft/sec²

- 2) Emergency Spillway: Assuming flow at critical depth in a trapezoidal channel.

FORMULA USED: $Q = C_2 \cdot b \cdot H_m^{1.5}$

Q = Discharge in cfs

C₂ = Discharge coefficient from Table 8-7 page 8-58 (Handbook of Hydraulics by King-Brater)

b = bottom width of spillway channel

H_m = energy head

TABLE 5
RESULTS OF FLOOD ROUTINGS

Ratio of PMF	Peak Inflow (cfs)	Peak Lake Elevation (ft, MSL)	Total Storage (acre-ft)	Peak Outflow (cfs)	Depth (ft.) Over Top of Dam
-	0	*800.0	51	0	-
0.10	320	801.2	64	214	-
0.15	481	801.4	67	345	-
0.20	641	801.6	70	493	-
0.25	801	801.7	72	643	-
0.30	961	801.9	73	786	-
0.36	1,153	**802.0	75	925	0
0.40	1,282	802.1	77	1,064	0.1
0.50	1,602	802.3	80	1,339	0.3
0.75	2,403	802.6	87	2,084	0.6
1.00	3,204	803.0	93	2,886	1.0

The percentage of the PMF that will reach the top of the dam is 36 percent.

*Principal spillway crest elevation

**Top of dam elevation

PMF RATIOS
INPUT DATA

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

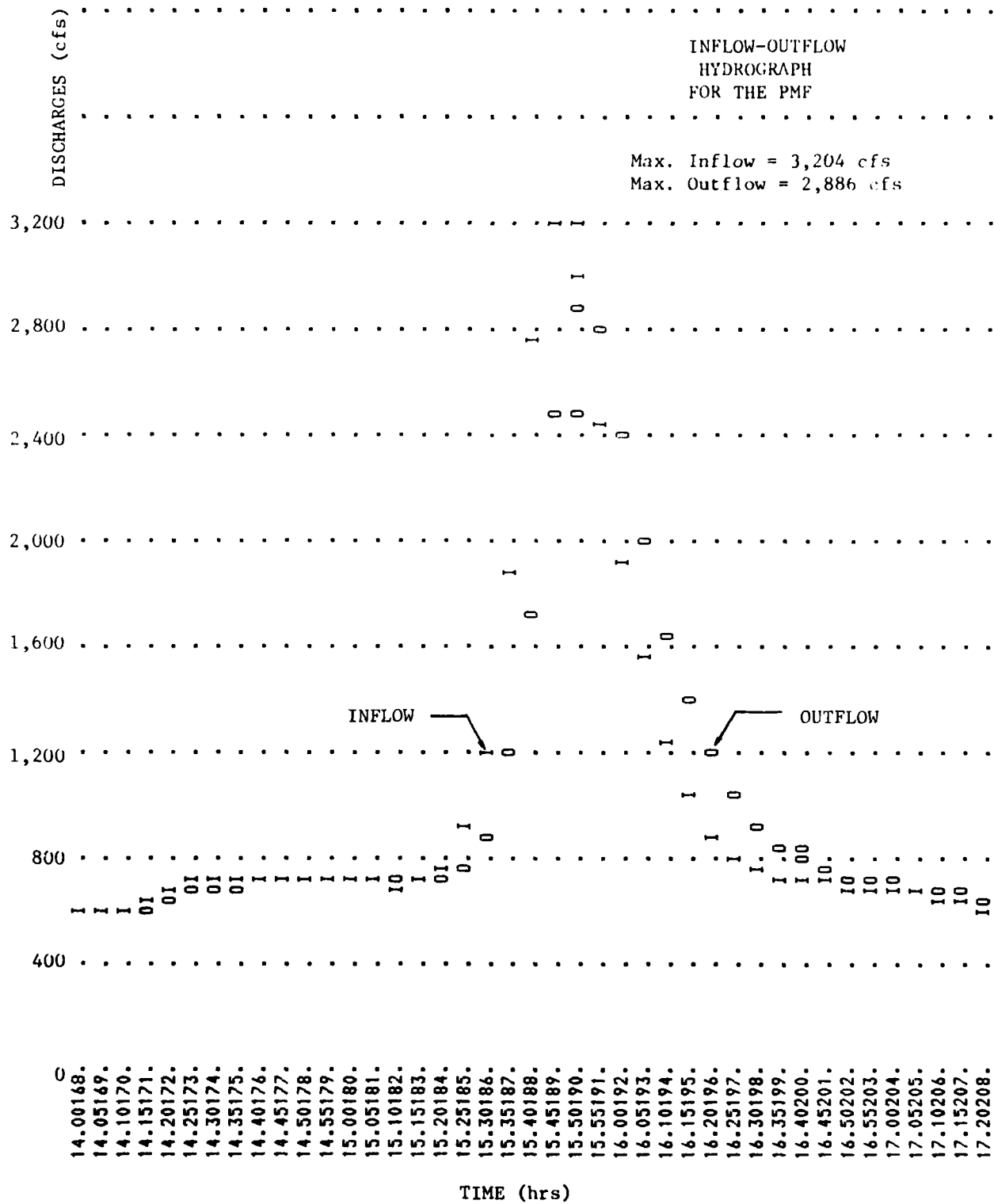
OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8	RATIO 9																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
HYDROGRAPH AT	1	0.29	1	0.10	0.15	0.20	0.25	0.30	0.40	0.50	0.75	1.00																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
	(0.75)	(9.07)	(13.61)	(18.15)	(22.68)	(27.22)	(31.75)	(36.29)	(40.82)	(45.37)	(49.90)	(54.43)	(58.96)	(63.49)	(68.02)	(72.55)	(77.08)	(81.61)	(86.14)	(90.67)	(95.20)	(99.73)	(104.26)	(108.79)	(113.32)	(117.85)	(122.38)	(126.91)	(131.44)	(135.97)	(140.50)	(145.03)	(149.56)	(154.09)	(158.62)	(163.15)	(167.68)	(172.21)	(176.74)	(181.27)	(185.80)	(190.33)	(194.86)	(199.39)	(203.92)	(208.45)	(212.98)	(217.51)	(222.04)	(226.57)	(231.10)	(235.63)	(240.16)	(244.69)	(249.22)	(253.75)	(258.28)	(262.81)	(267.34)	(271.87)	(276.40)	(280.93)	(285.46)	(289.99)	(294.52)	(299.05)	(303.58)	(308.11)	(312.64)	(317.17)	(321.70)	(326.23)	(330.76)	(335.29)	(339.82)	(344.35)	(348.88)	(353.41)	(357.94)	(362.47)	(367.00)	(371.53)	(376.06)	(380.59)	(385.12)	(389.65)	(394.18)	(398.71)	(403.24)	(407.77)	(412.30)	(416.83)	(421.36)	(425.89)	(430.42)	(434.95)	(439.48)	(444.01)	(448.54)	(453.07)	(457.60)	(462.13)	(466.66)	(471.19)	(475.72)	(480.25)	(484.78)	(489.31)	(493.84)	(498.37)	(502.90)	(507.43)	(511.96)	(516.49)	(521.02)	(525.55)	(530.08)	(534.61)	(539.14)	(543.67)	(548.20)	(552.73)	(557.26)	(561.79)	(566.32)	(570.85)	(575.38)	(579.91)	(584.44)	(588.97)	(593.50)	(598.03)	(602.56)	(607.09)	(611.62)	(616.15)	(620.68)	(625.21)	(629.74)	(634.27)	(638.80)	(643.33)	(647.86)	(652.39)	(656.92)	(661.45)	(665.98)	(670.51)	(675.04)	(679.57)	(684.10)	(688.63)	(693.16)	(697.69)	(702.22)	(706.75)	(711.28)	(715.81)	(720.34)	(724.87)	(729.40)	(733.93)	(738.46)	(742.99)	(747.52)	(752.05)	(756.58)	(761.11)	(765.64)	(770.17)	(774.70)	(779.23)	(783.76)	(788.29)	(792.82)	(797.35)	(801.88)	(806.41)	(810.94)	(815.47)	(819.99)	(824.52)	(829.05)	(833.58)	(838.11)	(842.64)	(847.17)	(851.70)	(856.23)	(860.76)	(865.29)	(869.82)	(874.35)	(878.88)	(883.41)	(887.94)	(892.47)	(896.99)	(901.52)	(906.05)	(910.58)	(915.11)	(919.64)	(924.17)	(928.70)	(933.23)	(937.76)	(942.29)	(946.82)	(951.35)	(955.88)	(960.41)	(964.94)	(969.47)	(973.99)	(978.52)	(983.05)	(987.58)	(992.11)	(996.64)	(1001.17)	(1005.70)	(1010.23)	(1014.76)	(1019.29)	(1023.82)	(1028.35)	(1032.88)	(1037.41)	(1041.94)	(1046.47)	(1050.99)	(1055.52)	(1060.05)	(1064.58)	(1069.11)	(1073.64)	(1078.17)	(1082.70)	(1087.23)	(1091.76)	(1096.29)	(1100.82)	(1105.35)	(1109.88)	(1114.41)	(1118.94)	(1123.47)	(1127.99)	(1132.52)	(1137.05)	(1141.58)	(1146.11)	(1150.64)	(1155.17)	(1159.70)	(1164.23)	(1168.76)	(1173.29)	(1177.82)	(1182.35)	(1186.88)	(1191.41)	(1195.94)	(1200.47)	(1204.99)	(1209.52)	(1214.05)	(1218.58)	(1223.11)	(1227.64)	(1232.17)	(1236.70)	(1241.23)	(1245.76)	(1250.29)	(1254.82)	(1259.35)	(1263.88)	(1268.41)	(1272.94)	(1277.47)	(1281.99)	(1286.52)	(1291.05)	(1295.58)	(1300.11)	(1304.64)	(1309.17)	(1313.70)	(1318.23)	(1322.76)	(1327.29)	(1331.82)	(1336.35)	(1340.88)	(1345.41)	(1349.94)	(1354.47)	(1358.99)	(1363.52)	(1368.05)	(1372.58)	(1377.11)	(1381.64)	(1386.17)	(1390.70)	(1395.23)	(1399.76)	(1404.29)	(1408.82)	(1413.35)	(1417.88)	(1422.41)	(1426.94)	(1431.47)	(1435.99)	(1440.52)	(1445.05)	(1449.58)	(1454.11)	(1458.64)	(1463.17)	(1467.70)	(1472.23)	(1476.76)	(1481.29)	(1485.82)	(1490.35)	(1494.88)	(1499.41)	(1503.94)	(1508.47)	(1512.99)	(1517.52)	(1522.05)	(1526.58)	(1531.11)	(1535.64)	(1540.17)	(1544.70)	(1549.23)	(1553.76)	(1558.29)	(1562.82)	(1567.35)	(1571.88)	(1576.41)	(1580.94)	(1585.47)	(1589.99)	(1594.52)	(1599.05)	(1603.58)	(1608.11)	(1612.64)	(1617.17)	(1621.70)	(1626.23)	(1630.76)	(1635.29)	(1639.82)	(1644.35)	(1648.88)	(1653.41)	(1657.94)	(1662.47)	(1666.99)	(1671.52)	(1676.05)	(1680.58)	(1685.11)	(1689.64)	(1694.17)	(1698.70)	(1703.23)	(1707.76)	(1712.29)	(1716.82)	(1721.35)	(1725.88)	(1730.41)	(1734.94)	(1739.47)	(1743.99)	(1748.52)	(1753.05)	(1757.58)	(1762.11)	(1766.64)	(1771.17)	(1775.70)	(1780.23)	(1784.76)	(1789.29)	(1793.82)	(1798.35)	(1802.88)	(1807.41)	(1811.94)	(1816.47)	(1820.99)	(1825.52)	(1830.05)	(1834.58)	(1839.11)	(1843.64)	(1848.17)	(1852.70)	(1857.23)	(1861.76)	(1866.29)	(1870.82)	(1875.35)	(1879.88)	(1884.41)	(1888.94)	(1893.47)	(1897.99)	(1902.52)	(1907.05)	(1911.58)	(1916.11)	(1920.64)	(1925.17)	(1929.70)	(1934.23)	(1938.76)	(1943.29)	(1947.82)	(1952.35)	(1956.88)	(1961.41)	(1965.94)	(1970.47)	(1974.99)	(1979.52)	(1984.05)	(1988.58)	(1993.11)	(1997.64)	(2002.17)	(2006.70)	(2011.23)	(2015.76)	(2020.29)	(2024.82)	(2029.35)	(2033.88)	(2038.41)	(2042.94)	(2047.47)	(2051.99)	(2056.52)	(2061.05)	(2065.58)	(2070.11)	(2074.64)	(2079.17)	(2083.70)	(2088.23)	(2092.76)	(2097.29)	(2101.82)	(2106.35)	(2110.88)	(2115.41)	(2119.94)	(2124.47)	(2128.99)	(2133.52)	(2138.05)	(2142.58)	(2147.11)	(2151.64)	(2156.17)	(2160.70)	(2165.23)	(2169.76)	(2174.29)	(2178.82)	(2183.35)	(2187.88)	(2192.41)	(2196.94)	(2201.47)	(2205.99)	(2210.52)	(2215.05)	(2219.58)	(2224.11)	(2228.64)	(2233.17)	(2237.70)	(2242.23)	(2246.76)	(2251.29)	(2255.82)	(2260.35)	(2264.88)	(2269.41)	(2273.94)	(2278.47)	(2282.99)	(2287.52)	(2292.05)	(2296.58)	(2301.11)	(2305.64)	(2310.17)	(2314.70)	(2319.23)	(2323.76)	(2328.29)	(2332.82)	(2337.35)	(2341.88)	(2346.41)	(2350.94)	(2355.47)	(2359.99)	(2364.52)	(2369.05)	(2373.58)	(2378.11)	(2382.64)	(2387.17)	(2391.70)	(2396.23)	(2400.76)	(2405.29)	(2409.82)	(2414.35)	(2418.88)	(2423.41)	(2427.94)	(2432.47)	(2436.99)	(2441.52)	(2446.05)	(2450.58)	(2455.11)	(2459.64)	(2464.17)	(2468.70)	(2473.23)	(2477.76)	(2482.29)	(2486.82)	(2491.35)	(2495.88)	(2500.41)	(2504.94)	(2509.47)	(2513.99)	(2518.52)	(2523.05)	(2527.58)	(2532.11)	(2536.64)	(2541.17)	(2545.70)	(2550.23)	(2554.76)	(2559.29)	(2563.82)	(2568.35)	(2572.88)	(2577.41)	(2581.94)	(2586.47)	(2590.99)	(2595.52)	(2600.05)	(2604.58)	(2609.11)	(2613.64)	(2618.17)	(2622.70)	(2627.23)	(2631.76)	(2636.29)	(2640.82)	(2645.35)	(2649.88)	(2654.41)	(2658.94)	(2663.47)	(2667.99)	(2672.52)	(2677.05)	(2681.58)	(2686.11)	(2690.64)	(2695.17)	(2699.70)	(2704.23)	(2708.76)	(2713.29)	(2717.82)	(2722.35)	(2726.88)	(2731.41)	(2735.94)	(2740.47)	(2744.99)	(2749.52)	(2754.05)	(2758.58)	(2763.11)	(2767.64)	(2772.17)	(2776.70)	(2781.23)	(2785.76)	(2790.29)	(2794.82)	(2799.35)	(2803.88)	(2808.41)	(2812.94)	(2817.47)	(2821.99)	(2826.52)	(2831.05)	(2835.58)	(2840.11)	(2844.64)	(2849.17)	(2853.70)	(2858.23)	(2862.76)	(2867.29)	(2871.82)	(2876.35)	(2880.88)	(2885.41)	(2889.94)	(2894.47)	(2898.99)	(2903.52)	(2908.05)	(2912.58)	(2917.11)	(2921.64)	(2926.17)	(2930.70)	(2935.23)	(2939.76)	(2944.29)	(2948.82)	(2953.35)	(2957.88)	(2962.41)	(2966.94)	(2971.47)	(2975.99)	(2980.52)	(2985.05)	(2989.58)	(2994.11)	(2998.64)	(3003.17)	(3007.70)	(3012.23)	(3016.76)	(3021.29)	(3025.82)	(3030.35)	(3034.88)	(3039.41)	(3043.94)	(3048.47)	(3052.99)	(3057.52)	(3062.05)	(3066.58)	(3071.11)	(3075.64)	(3080.17)	(3084.70)	(3089.23)	(3093.76)	(3098.29)	(3102.82)	(3107.35)	(3111.88)	(3116.41)	(3120.94)	(3125.47)	(3129.99)	(3134.52)	(3139.05)	(3143.58)	(3148.11)	(3152.64)	(3157.17)	(3161.70)	(3166.23)	(3170.76)	(3175.29)	(3179.82)	(3184.35)	(3188.88)	(3193.41)	(3197.94)	(3202.47)	(3206.99)	(3211.52)	(3216.05)	(3220.58)	(3225.11)	(3229.64)	(3234.17)	(3238.70)	(3243.23)	(3247.76)	(3252.29)	(3256.82)	(3261.35)	(3265.88)	(3270.41)	(3274.94)	(3279.47)	(3283.99)	(3288.52)	(3293.05)	(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1	ELEVATION	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	STORAGE	800.00	800.00	802.00
	OUTFLOW	51.	51.	75.
		0.	0.	925.

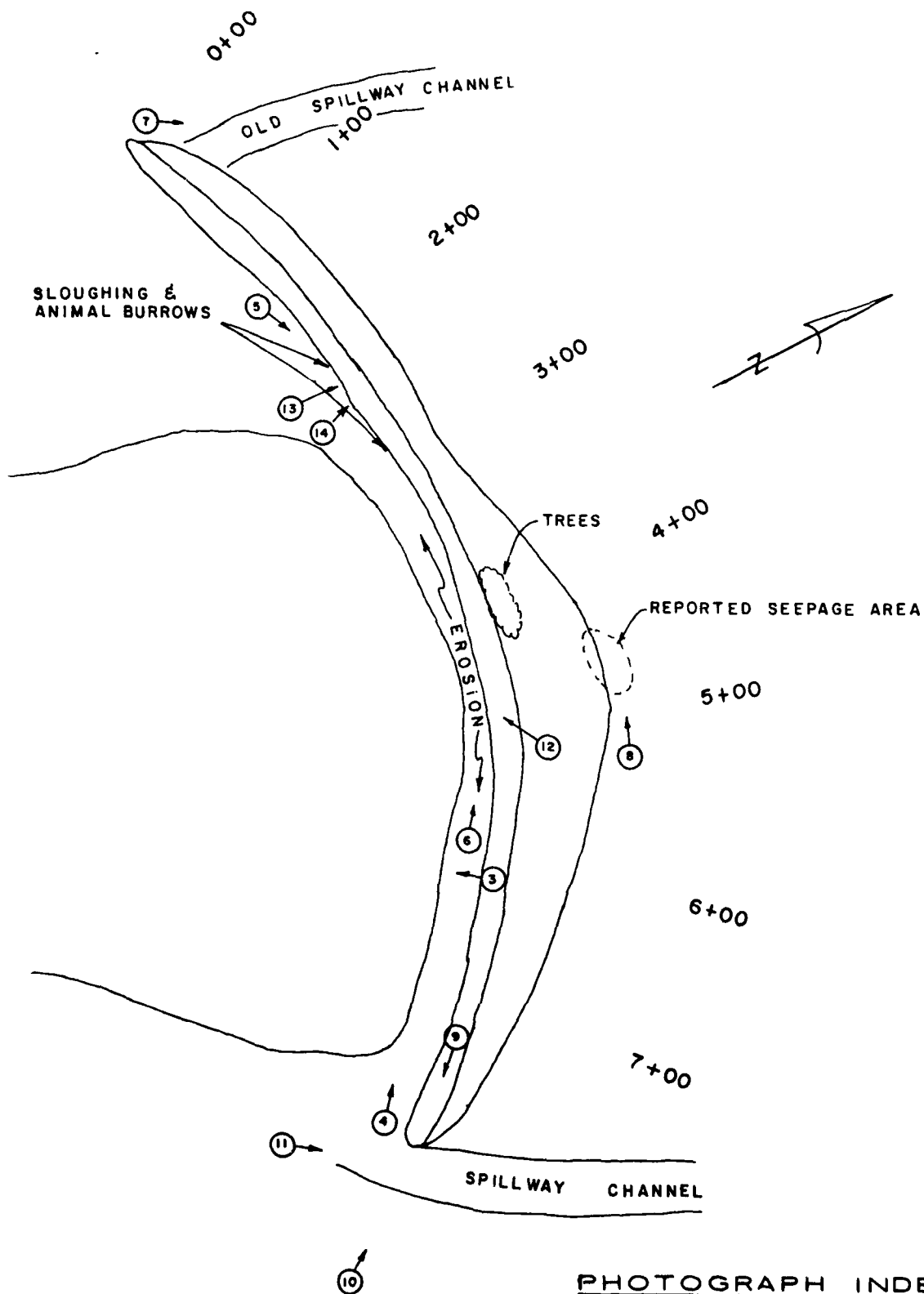
RATIO OF PMF	MAXIMUM RESERVOIR U.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.10	801.18	0.00	64.	214.	0.00	16.00	0.00
0.15	801.40	0.00	67.	345.	0.00	15.92	0.00
0.20	801.59	0.00	70.	493.	0.00	15.92	0.00
0.25	801.73	0.00	72.	643.	0.00	15.92	0.00
0.30	801.87	0.00	73.	786.	0.00	15.92	0.00
0.40	802.09	0.09	77.	1064.	0.25	15.92	0.00
0.50	802.26	0.26	80.	1339.	0.42	15.92	0.00
0.75	802.64	0.64	87.	2084.	0.75	15.83	0.00
1.00	802.95	0.95	93.	2886.	1.00	15.83	0.00

PMF RATIOS
OUTPUT DATA



APPENDIX D

Photographs



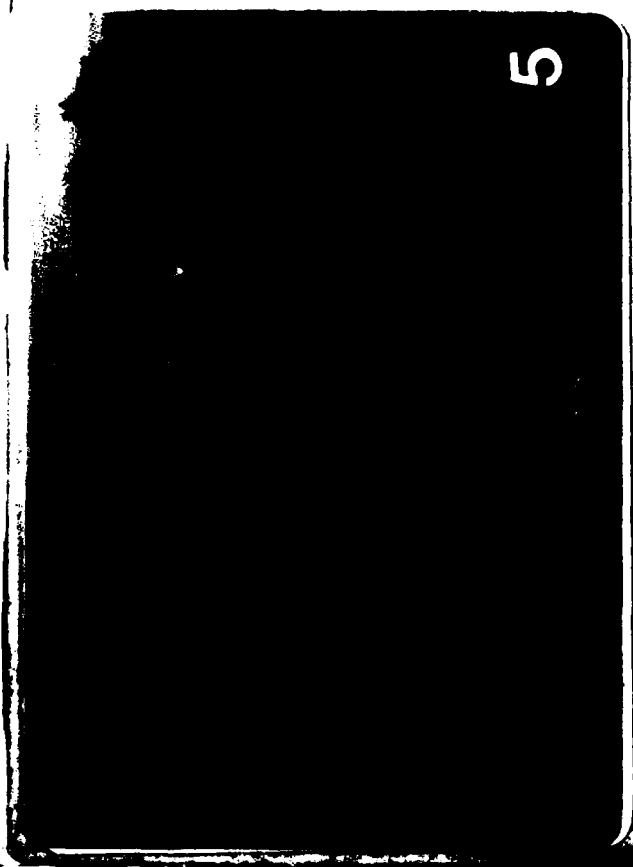
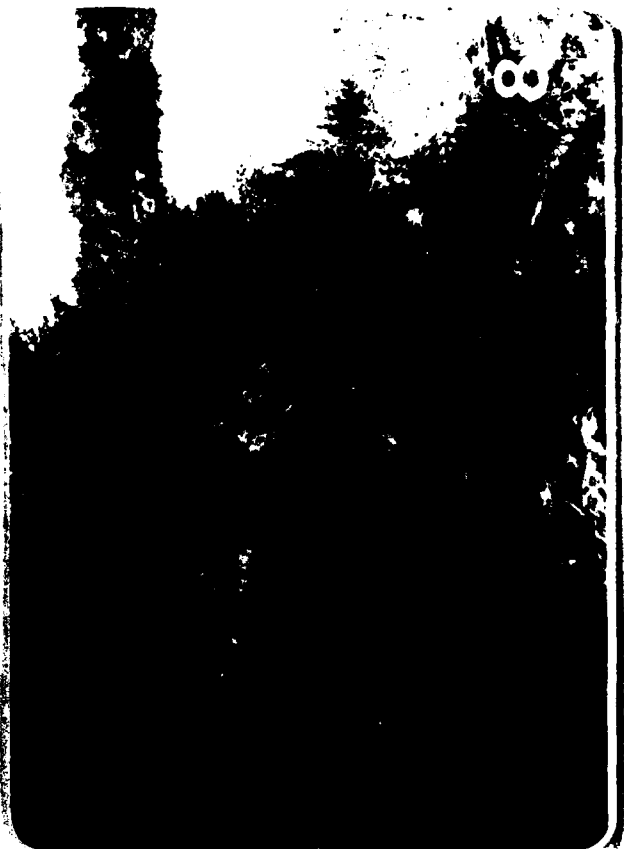
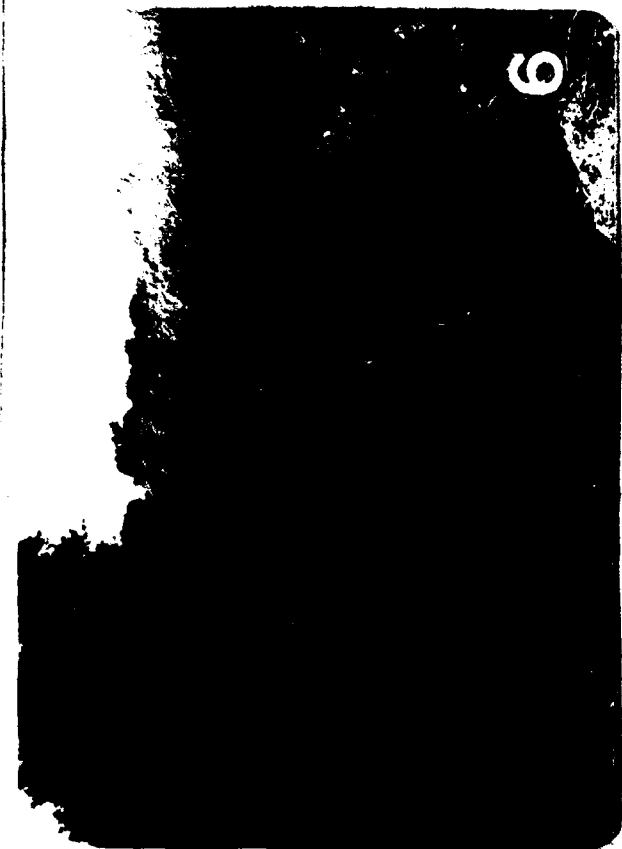
PHOTOGRAPH INDEX
EASTLAND LAKE DAM
MO. No. 20444

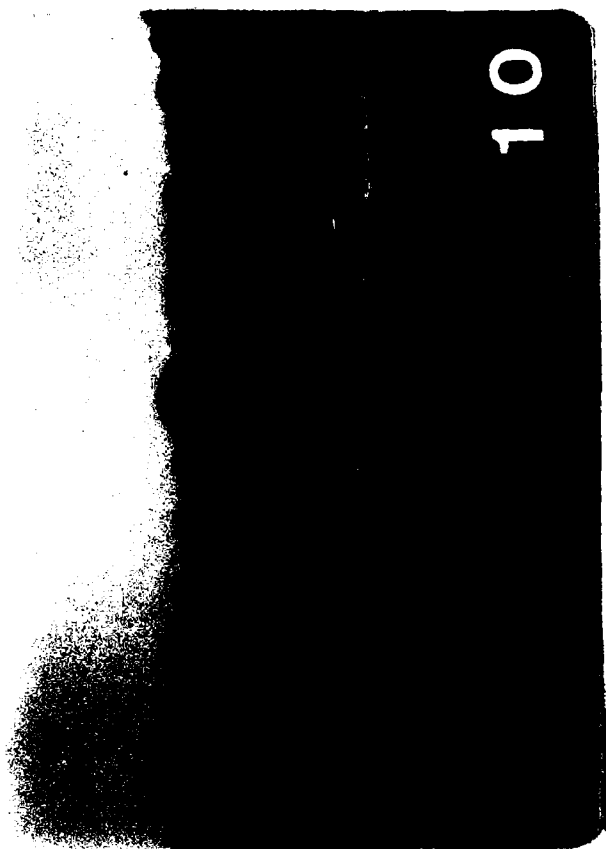
LIST OF PHOTOGRAPHS

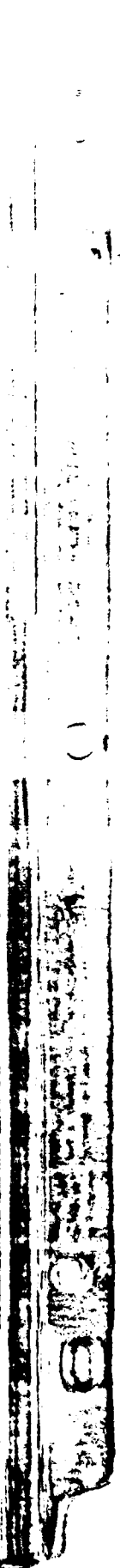
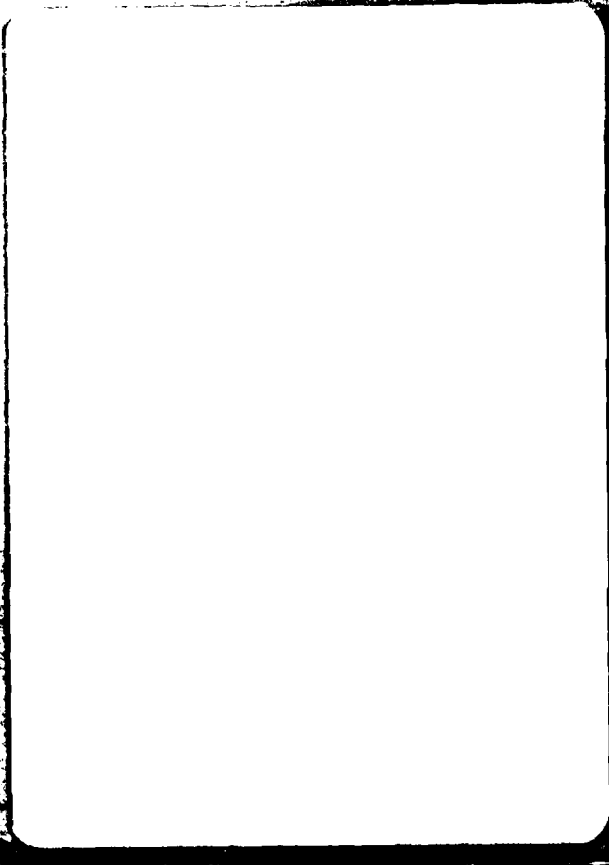
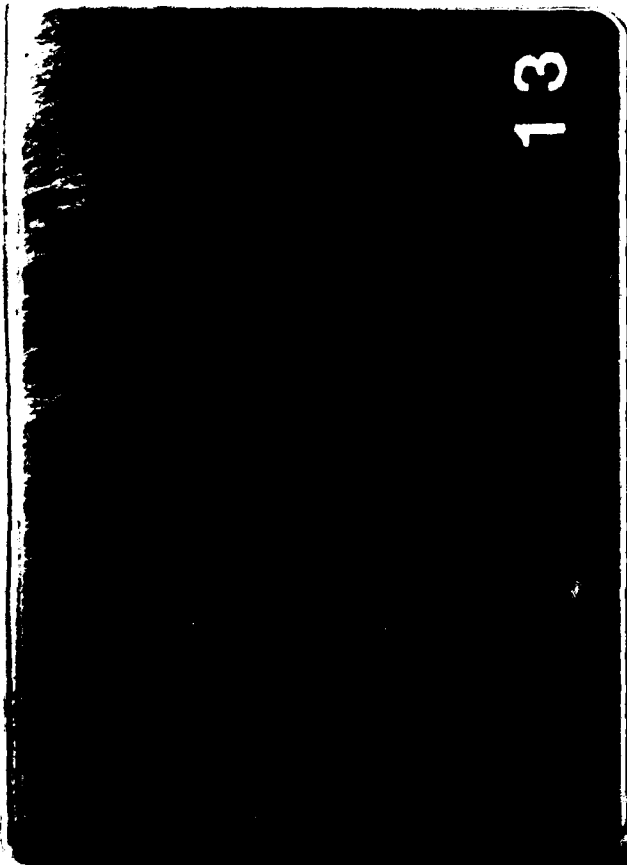
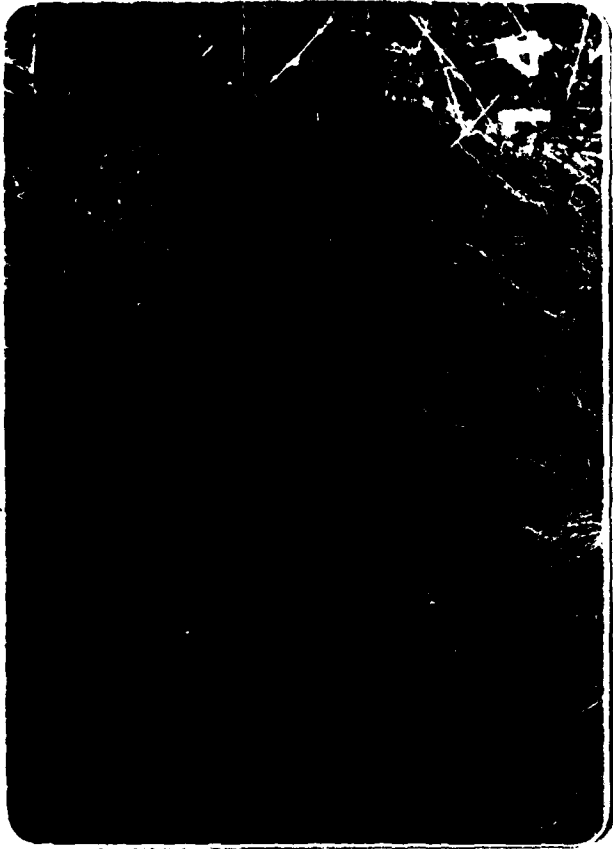
<u>PHOTO NO.</u>	<u>DESCRIPTION</u>
1	Aerial View of Lake and Dam
2	Aerial View of Lake and Dam
3	View of Watershed and Reservoir (Looking South)
4	Embankment Crest (Looking West)
5	Upstream Face of Dam (Looking Northeast)
6	Upstream Face of Dam (Looking Northwest)
7	Downstream Face of Dam (Looking East)
8	Downstream Face of Dam (Looking West)
9	View Across Spillway Channel (Looking East)
10	View Across Spillway Channel (Looking West)
11	Downstream Spillway Channel (Looking North)
12	Crest of Embankment
13	Upstream Face of Dam (Looking Northeast)
14	Upstream Face of Dam (Looking Northeast)

A high-contrast, black and white image of a dark, textured surface, possibly a book cover or endpaper. The texture is grainy and uneven, with some lighter areas suggesting wear or light reflection. In the upper right corner, there is a large, white, stylized number '2'. The overall appearance is that of a scan of a physical document.

A dark, textured book cover, possibly black or dark brown, with a small white label in the top right corner. The cover appears to be made of a material like cloth or leather. The label is rectangular and contains some text, but it is too small and blurry to read. The overall appearance is that of an old or well-used book.







DATE
FILMED
— 8